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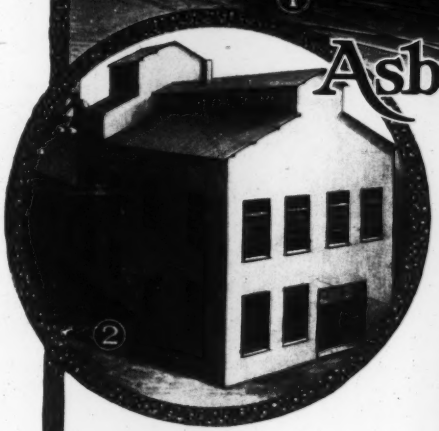

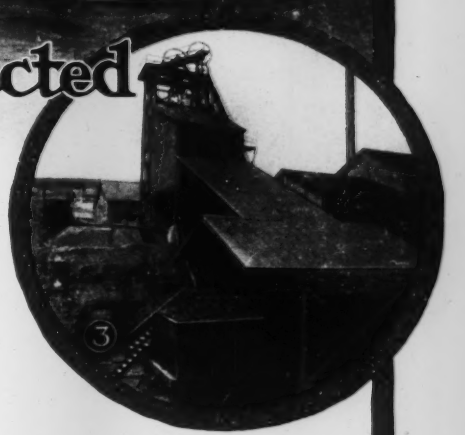

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Engineering News

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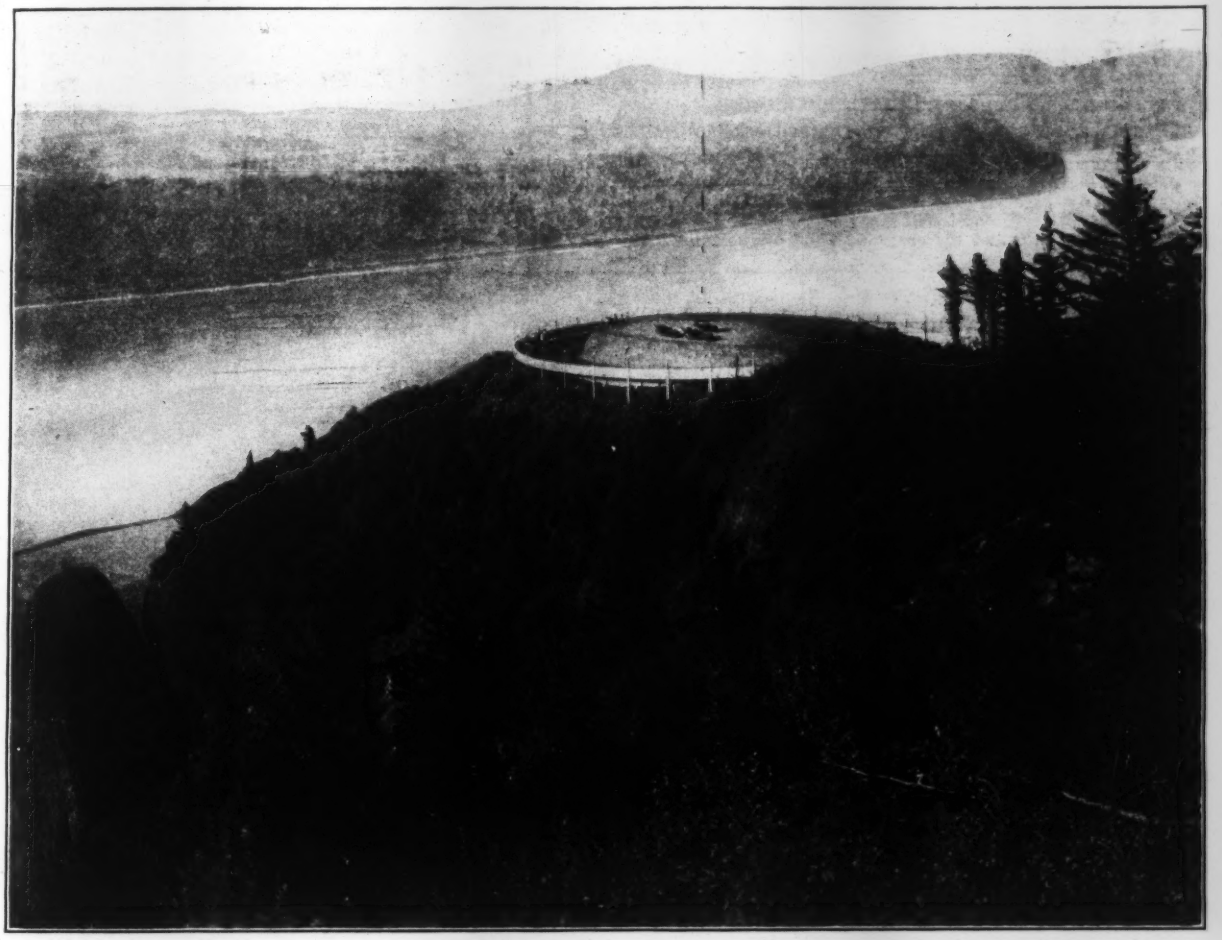
Multnomah County Roads in the State of Oregon

The County of Multnomah, Oregon, of which Portland is the county seat, has spent approximately $2,250,000 on highway construction during the years of 1914 and 1915, of which $1,250,000 was from a special bond issue for the hard-surfacing of 70 mi. of road. This hard-surfacing consisted of 39.5 mi. on the Columbia River Highway, of which approximately 30 mi. is new location and 9.5 mi. on old macadamized road. The remaining 30.5 mi. of the highway is on an old location, but has been realigned, and all grades exceeding 5% have been eliminated or reduced to 5% or less.

All bridges, trestles and culverts have been replaced with modern concrete construction or fills, and all important grade crossings have been eliminated by the use of viaducts or underground crossings. The Columbia River Highway has 17 bridges and viaducts, whose added length of span amounts to 3,699 ft. All of these bridges and viaducts were designed to add to the attractiveness of this now well-known scenic district. On six other paved highways radiating from the City of Portland, which have a total length of 30.5 mi., there were built three concrete bridges and viaducts, the sum of whose spans equals 394 ft.



A HIGH POINT ON MULTNOMAH COUNTY HIGHWAY, COLUMBIA RIVER VALLEY, OREGON

Approximately 60 mi. of the hard-surfacing was of asphaltic concrete (bitulithic or Warrenite) and 10 mi. was concrete pavement of 1 : 1½ : 3 mixture, one-course

construction. All of the asphaltic concrete, except 26 mi., was laid on waterbound macadam base, not less than 6 in. in depth and averaging 8 in. All of the pavements were 18 ft. in width, with a 2-ft. macadam shoulder. The contracts were awarded June 9, and 60 mi. had been finished by the last day of November.

It is interesting to note that 541 bids were received. Seven contractors received awards. There were few bids from small firms, owing to the fact that all pavement was laid under a 10-yr. maintenance bond with a 5-yr. guarantee of workmanship and materials. The cost of the paving is well within the estimated amount of $17,857 per mi.; the engineering cost is to date 2% of the construction costs, but will probably reach 2½% upon completion of the work.

The County Engineer of Multnomah County is Herbert Nann.

Data for Water-Works Design in Tropical Countries

The following extracts from the 1915 annual report of the Governor of Porto Rico are contained in the report of the Division of Sanitation of the island, F. W. Dalrymple, Sanitary Engineer, and while relating specifically to Porto Rican conditions would probably prove of value to engineers called upon to design water-works in other Spanish-American countries in the tropics or subtropics:

All possible data have been collected as to the amount of water actually used by the municipalities of the island so that they might serve as a basis for the design of new works. As few of the towns use meters (and none of them have the entire supply metered) it is difficult to get precise facts. The average per capita consumption per day ranged from 60 liters (16 gal.) in Guayama, where there is a shortage of water and the people can use it only from 8 a.m. to 4 p.m., to 130 liters (34 gal.) in San Juan and Arecibo. Both of the last-named places have meters in very general use, although they were not introduced into Arecibo until 1913; it was found that their use reduced the consumption of water from 370 liters (98 gal.) to 130 liters per capita per day.

From two years' pumping records of the San Juan works, it is found that the maximum daily use of water is liable to be 25% greater than the average, and the maximum hourly use may be one-third greater than this maximum. As the use of water is bound to increase with the more extended introduction of sewers and plumbing, an average consumption of 150 liters (40 gal.) per capita per day is believed to be a safe assumption in designing new works.

The size of the main pipe line supplying the town, however, must be sufficient to deliver water at the maximum hourly rate, which is one and one-fourth, one and one-third or one and two-thirds times the average rate; this means 250 liters per day on the given assumptions.

In addition to the above, the pipes must have sufficient capacity for fire service. In Porto Rico the number of fire streams necessary may be taken at twice the square root of the population in thousands, and the average rate of consumption of a fire stream is 1,000 liters per day. In the smaller and poorer towns it is believed these rates would be excessive and that an average per capita consumption of 100 liters per day would be ample. If x is taken as the population of a town in thousands, the number of cubic meters required under various conditions may be stated as follows:

Rate per 24 Hr.	First-Class Towns, Cu.M.	Second-Class Towns, Cu.M.
Average rate	150x	100x
Maximum rate, no fire service	250x	166x
Maximum rate with fire service	$180x + 2000\sqrt{x}$	$120x + 2000\sqrt{x}$

Difficult Falsework Erection for 242-Ft. Concrete Arch

On the line of the new California state highway that is to extend the entire length of the state from north to south, a distance of over 800 mi., there is now under construction a concrete arch bridge of 242-ft. span, which involves some difficult problems in erection.

The bridge is to cross the Pitt River near Baird, Calif., about 50 mi. south of Mount Shasta. Most of the rivers of California are either entirely dry by the end of the long rainless summer and fall or else have a flow of only trifling amount. The Pitt River, however, even at the end of the dry season is a large stream. It drains a great area of country lying east of Mount Shasta and is fed by underground streams issuing from the great lava beds of Modoc and Lassen Counties.

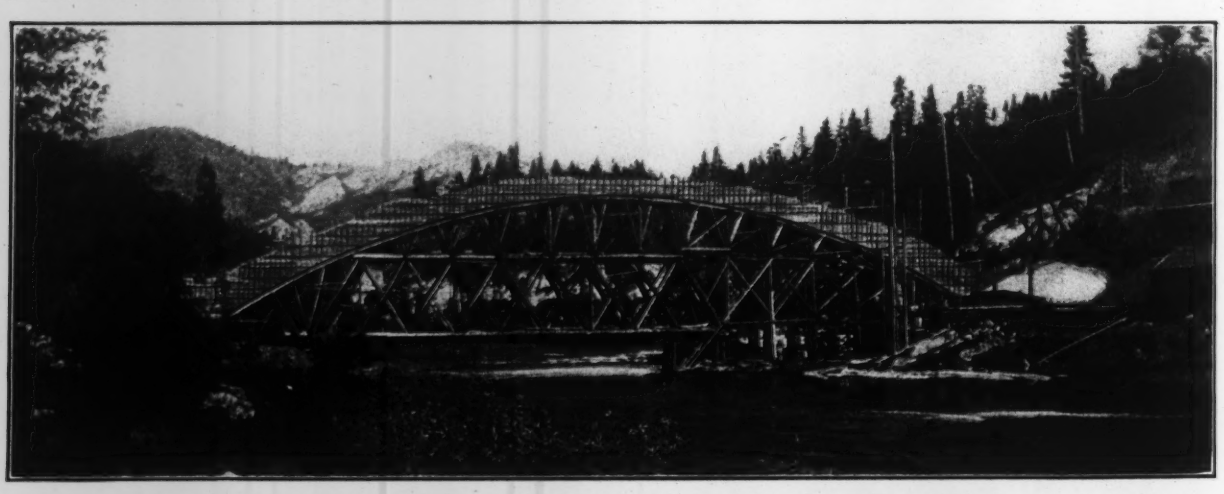


FIG. 1. HOWE TRUSS OF ROUND TIMBERS SUPPORTING FALSEWORK FOR 242-FT. CONCRETE ARCH BRIDGE

At the site of the crossing, the exposed rock on either side of the stream offers natural abutments for an arch structure, and a concrete arch was decided upon. Concrete structures are in fact used in California on permanent bridge work wherever conditions permit. The bed of the Pitt River at the bridge site, however, is solid rock; the depth of water in the channel is about 30 ft. and there is a rapid current. Driving piles or erecting trestle bents to support the falsework in the ordinary manner was not feasible.

The contract for constructing the bridge was awarded by the State Highway Commission to the Ross Construction Co., of Sacramento, Calif., and the chief engineer of the company, George G. Pollock, devised the system

of falsework for erection illustrated herewith. As shown, a Howe truss is carried across the stream, being supported on trestle bents near each shore. This truss supports the struts and lagging on which the concrete arch is built.

The chief problem, however, was how to erect the truss itself. The gorge to be crossed was too deep and narrow to permit of erecting the span on shore and shoving it out endwise over the stream as has sometimes been done. Instead, Mr. Pollock devised a plan for erecting the truss span in place.

The lower chord of the truss is made up of sticks of round pine timber cut near the bridge site, and long enough so that only one joint is necessary—at the center of the span. This lower chord was made up first, half on each side of the river. Trestle bents were erected to support the truss at each end and extended as far out into the stream as the depth of the water would permit. The two halves of the lower chord were then swung into place, their shore ends resting on the trestle bents and the channel ends being supported by tackle from a ginpole on one bank and from an erection traveler on the other. While held in this way the two halves of the lower chord were joined. Then struts were placed on the under side of the chord, wire cables were stretched over the struts and the lower chord of the Howe truss became temporarily the top chord of a queen-post truss.

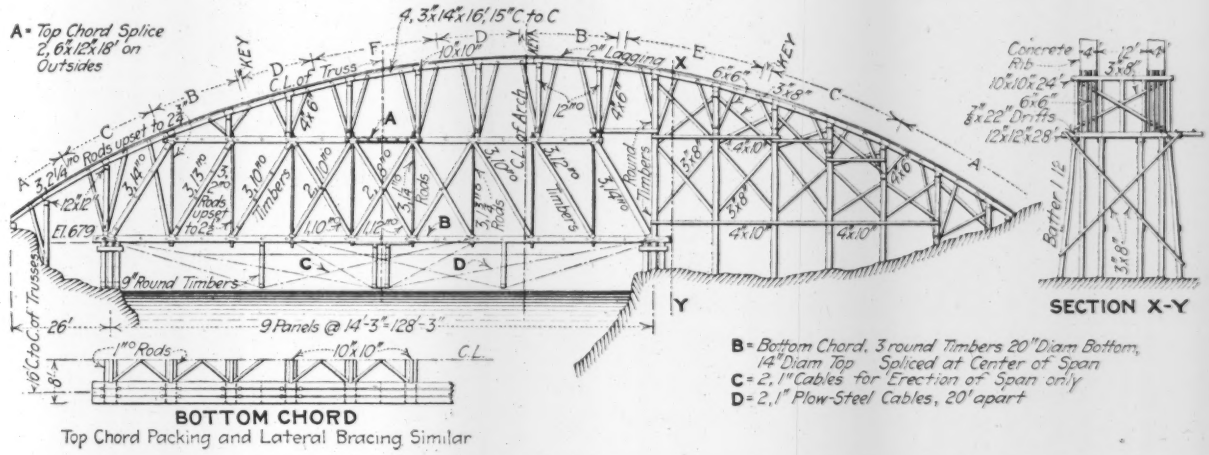


FIG. 2. FALSEWORK FOR BAIRD BRIDGE, SHOWING METHOD OF ERECTING HOWE TRUSS

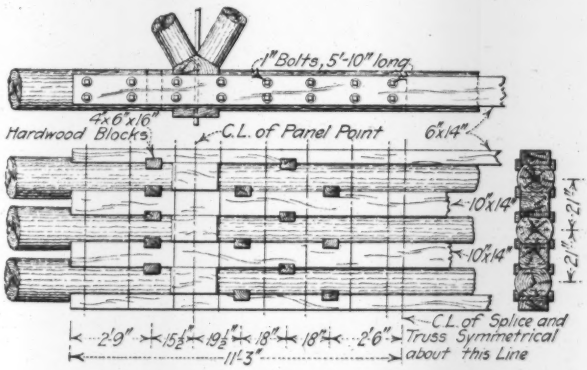


FIG. 3. DETAILS OF SPLICE FOR LOWER CHORD OF HOWE TRUSS

On this queen-post truss as a support the Howe truss was erected.

The splice used for joining the two halves of the lower chord is shown herewith. The use of the round sticks for the Howe truss gave an added margin of strength and stiffness and, what was most important, enabled the erection to be done rapidly with material available at the site, with the minimum of labor expended on it.

For the batter blocks between the ends of the braces and the lower chord, hard laurel wood was used.

The pouring of the arch ring is now in progress. This work is being done in successive sections, as indicated by the serial lettering on the accompanying drawing, and keys are to be left open at the crown and the haunches. These are to be poured after the rest of the arch ring.

Technical School Competition

In the engineering school of Ohio State University the practice is followed of having senior students, for thesis work, survey and report on projects of assistance to various communities within the state.

At Sidney three students prepared as a thesis for graduation in civil engineering, plans for eliminating railroad-grade crossings and for accompanying improvements. The city authorities paid the bare expense of doing the work, amounting to $150, which otherwise would have cost more than $1,000, for which expenditure no funds were available. The thesis thus prepared answered a double purpose: First, it supplied an original problem to be solved for graduation, and second, it furnished complete enough plans (not otherwise obtainable) so that a bond issue for carrying out the project could be submitted for vote at the November election.

Immediately after Thanksgiving six men began surveys for a combined water-power project and electric traction line between Chillicothe and Hillsboro. The proposed power development is on Paint Creek, about halfway between the two cities mentioned. The work will be done as thesis work, but is expected to have practical value, as there are scant transportation facilities in the region to be examined, and the water power to be generated could be practically all used in the proposed traction line without seeking further market.

Eight Years of Imhoff Tank Design and Operation--II*

By Karl Imhoff†

SYNOPSIS—The engineer who developed the form of two-story sewage-settling tank or modified septic tank bearing his name reviews eight years' German and American experience in design and operation of Imhoff tanks. The translator, who worked with Dr. Imhoff in Germany and was subsequently engaged on the design of Imhoff tanks for Baltimore, Md., has added a number of supplementary notes.

Tank Operation and Sludge Disposal

The operation of the settling chamber is very simple. From time to time the inclined partition walls should be cleaned by means of a broom or a squeegee. If the inclination of these walls is at least 1.2 vertical to 1 horizontal the sludge will glide off of its own accord. A greater inclination is necessary only in plants where two inclined surfaces meet each other so as to form a solid angle whose vertex or line of intersection inclines more to the horizontal than the wall surfaces themselves.

In cleaning the inside surfaces of the settling chamber it is important that the slot does not become clogged. It may happen that large-sized solids have squeezed themselves through the coarse screens and have then become engaged in the slot, thus permitting sludge accumulations at this point. The plant attendant should be taught to recognize conditions of this kind quickly and to remove them immediately. The greater portion of such suspended matters as float on the influent side of the first scum board will generally sink of their own accord after a time. Sometimes it may prove advisable to expedite their sinking by spraying upon them with a hose. Pieces of wood, cork, etc., which will not sink should be skimmed off occasionally.

In tanks where one sedimentation chamber feeds more than one sludge chamber the direction of flow of the sewage should be reversed about once every three weeks, that the sludge chambers may receive sludge uniformly. Before reversing the direction of flow it is necessary to skim off the floating matters from the surface of the settling chamber, so that they may not escape with the effluent. Such recovered floating matters should be buried. Suspended matters are sometimes found to rise to the surface behind, as well as in front of, the first scum board. This will probably be a sign either that the inner surfaces of the settling chamber have not been kept sufficiently clean or that the sludge level has risen to the slot level and hence stopped up the slot and allowed sludge to accumulate above it in the settling chamber. If the latter is the case it will be necessary to discharge sludge.

The operation of the sludge chambers, which is simple in practice, since all that is necessary is occasionally to discharge some of the sludge, is very interesting theoretically and has awakened much scientific discussion in the last few years. When the first Imhoff tanks were built in the Emscher district it was assumed, in accordance with what was universally believed at that time, that the decomposition of sludge could not proceed if flow were not maintained in the sludge chamber. However, it was considered most important of all to keep the sewage itself as fresh as possible by separating it entirely from the sludge, and so, in order to maintain the decomposition of the sludge, the sludge chambers were provided with agitation and water flushing devices. Sludge inoculation and the addition of chemicals were also considered.

The operation of the first plant built, that at Recklinghausen, showed, however, that the sludge decomposed properly without artificial stimulus. It was noted that the tank required about eight months for what came to be termed the ripening period. During these eight months it was necessary to discharge from time to time incompletely decomposed and foul-smelling sludge. This foul-smelling sludge was buried. It is significant that one year later the buried sludge was found to be still in the same foul condition. After the completion of the above-mentioned period of eight months the sludge discharged from the tank was found to be nonobnoxious and easily dryable. From that time until now, eight years later, the sludge discharged from the Recklinghausen plant has consistently maintained its good quality.

Various Phases of Decomposition of Sludge

Now that the experience of eight years is available it is clear that there are a number of different ways in which municipal sludge may decompose, just as there are various paths of decomposition which may occur in other substances, such as those which are well known in the fermentation industries. There is only one method of decomposition for sewage sludge which is technically correct. This correct method is a combination of various processes occurring simultaneously. Proper decomposition is identified by the fact that it occurs entirely without objectionable odors. The effect of such decomposition upon the sludge is that it becomes black in color, that it gives an alkaline reaction, that it possesses a not unpleasant odor like that of rubber or warm sealing wax, and that it is easily dewatered.

The period that elapses from the time the tank is placed in operation until it begins to deliver good sludge is known as the ripening period, as above mentioned. It is possible to eliminate the ripening period entirely if the tank be inoculated with a proper amount of good sludge at the beginning of operation. Often, however, even without inoculation the tank will discharge good sludge from the first. This occurred in the fairly large plant at Essen Nordwest because at the time it was placed in operation a large number of cesspools which had been in use for decades, and which therefore contained ripe sludge, were emptied into the sewer system.

*Translated by Leslie C. Frank, Sanitary Engineer, United States Public Health Service, Washington, D. C.

†Division Engineer, Emscher Federation, Essen, Germany.

If a new tank does not become inoculated immediately, either artificially or naturally, the first sludge that fills the tank will be relatively fresh. If such sludge consists largely of fresh fecal matter it will at first be yellowish-gray in color, then gray and finally black. In the earlier part of the ripening period it will happen occasionally that acid decomposition will occur. Fecal matters attributable to vegetable diet incline toward acid decomposition, whereas a meat diet tends to produce an alkaline decomposition. The process of acid decomposition is extremely undesirable because then the sludge decomposes very slowly, cannot be dried easily and has an intensely objectionable odor. In addition, sludge that is in a stage of acid decomposition tends to attain a mass specific gravity less than that of water and to rise as a body to the surface of the sludge chamber. If a tank be operated in the proper manner, which will be discussed more in detail farther on, such acid decomposition will sooner or later be replaced by the proper alkaline decomposition.

Movements of Gas and Sludge

As soon as the ripening period has been passed the sludge is alkaline, black and odorless. The gases of decomposition cause particles of the sludge to rise to the surface of the sludge chamber, where they give up their gas content and again sink to the bottom. This faculty of giving up its gas content depends in large measure upon the fact that the sludge has, through its decomposition, lost its stickiness or, more properly, its viscosity, and hence its ability to hold gases. It is because of this process of rising and falling on the part of the sludge particles that the sludge mass as a whole becomes thoroughly mixed. Fresh sludge particles are continually entering the sludge chamber through the slot and, settling to the surface of the mass of decomposing sludge, are quickly mixed more or less uniformly therewith. Consequently in a very short time they are inoculated with the proper organisms. This makes it impossible for local acid processes to occur. That is why it is never possible to find in a tank which has passed the ripening period a layer of fresh or almost fresh sludge.

From time to time decomposed sludge is discharged through the sludge pipe, whose influent end is situated at the deepest point in the sludge chamber. A tank which has once passed the ripening period will always deliver good sludge if no gross errors of operation occur. With this assumption acid decomposition is impossible. Upon the surface of the sludge chamber a relatively thin layer of scum will form which will have to be removed not oftener than once a month at the most. Previous to its removal a stream of water should be directed upon it for a short time in order to throw down any easily settleable solids.

Much emphasis should be placed upon the difference between what has just been termed the scum layer and another phenomenon, namely, foaming or floating sludge. This latter is very similar in appearance to a mass of resistant, dark-colored soap bubbles, and also distinguishes itself from the proper scum layer by its ability to rise in the gas vents far above the tank water level. It consists simply of sludge in an improper state of decomposition and possesses a sufficiently high viscosity to enable it to imprison firmly its gases. This phenomenon should never occur in a properly operated tank. Its occurrence indicates, and this will be discussed more in detail farther on, that sludge should be discharged at once.

The fact that acid decomposition sometimes takes place in tanks which have not passed the ripening period has led to the assumption, from a scientific standpoint, that a certain amount of alkalinity should be present in the sewage if a proper working of the tank is to be expected. It has been assumed that the sludge should be mixed frequently with this alkaline sewage, and that there should always be present in the sludge chamber a greater amount of sewage than sludge. It has also been believed that it might be possible to combat acid decomposition by the addition of lime to the sewage or to the sludge. I have never been able to substantiate any of these assumptions. The addition of lime has never resulted beneficially in the Emscher district.

Addition of Lime to Prevent Acidity Not Advised

It may be interesting from a scientific standpoint to note that Dr. Spillner, chemist to the Emscher Federation (Dr. Spillner has since fallen on the field of battle), proposed a theory directly contrary to the one that acid decomposition might be combated by the addition of lime. He believed it possible that the addition of lime might instead promote the acid process, as the products of the acid bacteria were inimical to their own existence, and hence neutralization by means of lime would really improve their environment. Dr. Spillner further believed that if lime were not added the acid bacteria would sooner or later cause their own destruction. He pointed out the interesting fact that acid decomposition occurred very intensely in new tanks which during the period of construction had been filled with a rich solution of milk of lime and cement, and whose walls, certainly during the first period of operation, exuded a considerable amount of alkali.

Without considering more closely these interesting bacteriological theories it will suffice to say that practical experience with dozens of plants has not substantiated the statement that the addition of lime would be beneficial. I cannot advise such addition. All plants which are known to me and in which acid decomposition has occurred have sooner or later adjusted themselves of their own accord. Even the plant at Elberfeld, in which the incoming sludge is always acid because of the presence of particular trade wastes and the sewage of which is at times very strongly acid, has finally righted itself.

To achieve proper sludge decomposition therefore depends not upon the composition of the sewage, not upon its volume, not upon the relation of sewage to sludge. The sewage may in fact be continuously acid. *Proper decomposition depends only upon the sludge,* and sooner or later the sludge itself will develop a preponderance of the proper organisms. Once good decomposition has been established it must be maintained by always providing the necessary bacteriological environment. This condition will be fulfilled by a naturally simple procedure. The following rules should be observed:

Rules for Handling Sludge Satisfactorily

(1) Sludge should be discharged from each sludge chamber once every two to six weeks. This procedure will effect the maximum utilization of the sludge-drying beds. As soon as a sludge-drying bed is free, sludge should be discharged even if thereby the level of the

sludge in the tank should be considerably depressed. The tank may not be completely emptied of sludge but must always be left with a sufficient amount to insure the maintenance of the proper decomposition process. It will be necessary therefore to stop discharging sludge from the tank if its sludge begins to show signs of deterioration, or as dictated by experience, when the sludge remaining in the tank is approximately equivalent to one month's accumulation.

(2) In general the optimum position of the sludge level is about 3 ft. below the slot level. It ought never to be allowed to rise above the lower edge of the inclined diaphragm which limits the slot. It must certainly never be allowed to rise to a level at which the slot will be closed by the sludge.

(3) The elevation of the sludge surface may be determined by lowering into the sludge chamber a very thin piece of sheet iron about 1 sq.ft. in area, held in a horizontal position. The determination of the sludge level in this manner may not be relied upon absolutely, because the transition between sludge and supernatant is often very difficult to perceive. If the sludge level is too high this fact will evidence itself by the occurrence of gas bubbles on the surface of the settling chamber vertically above the slot, even though the slot has been cleaned from above and is known not to be clogged. Another evidence of an excessively high sludge level is the occurrence of floating sludge or in extreme cases foaming sludge. In either case it will be necessary to discharge sludge immediately from the bottom of the sludge chamber. It is never necessary to remove sludge proper from the gas vents. The normal scum layer must be removed occasionally, but the floating of sludge proper or the phenomenon of foaming is absolutely preventable. These phenomena occur only if sludge is not discharged at proper intervals.

The rules which have been formulated above, referring particularly to tanks that have passed the ripening period, hold also during the ripening period, which lasts on the average about six months. Even if the sludge is still fresh, or indeed acid, it must be removed from the tank as soon as any of the above-named symptoms appear. The foul-smelling sludge that is removed may be buried, or dosed with hypochlorite and spread out in a thin layer on the ground surface. If this procedure be followed the ripening period will sooner or later come to an end and the normal operation phase begin.

If it be desired to promote the early incidence of proper decomposition it will be necessary above all to make sure that the sludge does not lie quietly at the bottom of the sludge chamber. Its proper decomposition demands, as above explained, that it be constantly stirred. It also demands that the introduction of fresh organic matter and the discharge of decomposed organic matter be uniform. Proper decomposition may therefore be promoted by artificially mixing or stirring the sludge. In particular the scum layer should be frequently agitated by a jet of water or otherwise, and the sludge at the bottom of the chamber should be agitated by a water-stirring system. As a substitute the whole body of sludge may be pumped out and returned. If it be desired to promote the action still more, inoculation may be tried. For this purpose the tank must be emptied as far as possible. If then well-decomposed sludge from a properly operating tank be introduced into this empty tank to the amount of about one week's fresh sludge accumulation, it may be assumed that the tank has been sufficiently inoculated. Inoculation may also be acquired with smaller amounts of decomposed sludge. A small amount may be mixed with fresh sludge in the proportion of 1 : 1, placed in the tank and allowed to stand one week. The mixture will by that time have become sufficiently decomposed to permit the addition of its own volume of fresh sludge. This process may then be continued until a sufficient volume of properly decomposed sludge has been acquired.

What Performance May Be Expected?

The performance of any sedimentation device must always be limited to settleable solids. The total suspended solids which the sanitary chemist is accustomed to determine are generally derived by means of laboratory filtration methods. Such a determination may not be taken as a criterion in determining the performance of any settling device. Any laboratory method which is intended to measure such performance should be one which will determine the settleable solids only. In Germany it is customary to denote as settleable such matters as will settle in an interval of two hours from the sewage contained in a one-liter glass cone. The reading is therefore volumetric.

[For most American plants the volumetric method of determining settling-chamber performance is inapplicable because the volume of solids that will settle out of a reasonable volume of sewage is not readable with the desired precision. The following method has therefore been adopted in the experiments of the United States Public Health Service upon small sewage-treatment plants: (a) Total solids are determined on the influent sewage by the evaporation method. (b) Total solids are determined on the tank effluent by the evaporation method. (c) A cylinder of the tank effluent is kept quiescent for two hours and then 50 c.c. of the supernatant carefully removed and total solids determined on it by evaporation. $(a - b) \times 100 \div (a - c)$ is then the percentage performance of the tank with regard to settleable solids.—Translator.]

It may be expected of a properly designed settling tank that it remove at least 95% of the above-denoted settleable solids. In comparison with mechanical screens such a performance is relatively very high, since the best of such screens remove only from 10% to 15% of the settleable solids and hence at the most yield a performance of only about one-sixth that of sedimentation plants.

In cases where plain sedimentation is insufficient the performance of a settling tank may be improved in various ways. It is particularly easy to combine the process of disinfection with the settling process. There has been much experience in the United States with the hypochlorite method of disinfection. A long-time experiment conducted in one of the six tanks of the sewage plant of Essen-Ruhr, Germany, showed that the process of decomposition in the sludge chamber is not disturbed by the process of disinfection applied in the settling chamber. In other words the disinfection process fortunately limits itself to the sewage and may therefore be applied without hesitation to the settling chamber of an Imhoff tank.

Chemical-precipitation methods also may be used in connection with Imhoff tanks. It has been determined

that the sludge obtained by chemical-precipitation methods will decompose properly in an Imhoff tank sludge chamber. This fact solves the long-standing problem of handling the voluminous and not easily dryable sludge obtained from chemical precipitation.

In cases where it is necessary to treat the effluent of a sedimentation plant upon sprinkling filters it is particularly important that the sewage be freed of sludge-forming matters as far as possible and at the same time retain its fresh condition.

Sewage-treatment plants should be so designed as not to cause nuisance at any stage and so that the sludge may be dried without undue difficulty. When the sludge has once been dried it may be utilized in a number of ways, for example, to fill in low ground, as a fertilizer or as a fuel. The sludge obtained from mechanical screening plants is naturally less in volume than that derived from Imhoff tanks because of the lower performance of the former.

[In cases where the performance of fine screens is sufficiently high the sludge may be treated in separate digestion tanks. Or if the screenings are removed from the screen by water jet, as at Baltimore, the wash water may be led through a special Imhoff tank with relatively small settling chamber.—Translator.]

J. Herbert Shedd--A Pioneer Municipal Engineer*

J. Herbert Shedd, who died on Nov. 27, 1915, was born May 31, 1834, in the town of Pepperell, Mass. He descended from an old colonial family whose home was in Billerica, Mass., for many generations.

He obtained his early education in the public schools of Massachusetts and at Bridgewater Academy. His preparation for the engineering profession was obtained through a three years' service in the office of Thomas Doane, in Boston. This constituted the basis of his preparation for a lifework, and we find him at once taking up railroad work of importance and then establishing his office in Boston in 1859, when he began the practice of hydraulic and sanitary engineering. He continued his Boston office in partnership with Edward Sawyer for 40 yr.

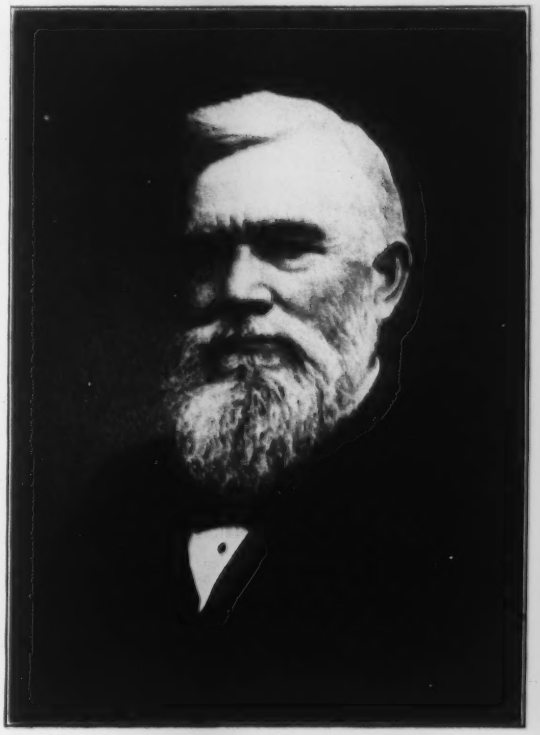
He was called upon by the City of Providence in 1866 to make investigations and recommend a plan for a water-supply and a system of water-works for that city, which he reported upon in 1868. He became a resident of Providence in 1869 and served the city in the capacity of chief engineer of the water-works until 1877. While chief engineer he reported, in 1874, upon a comprehensive plan for the sewage of Providence, which was partly carried out under his direction previous to his retirement from office.

In designing the water-works and sewerage systems of Providence, every element was studied by him fundamentally, and nothing was copied. His designs have been much referred to and have a European reputation. In connection with this work Mr. Shedd probably did more to improve the quality of American hydraulic cement than had been accomplished by any other engineer, due to the rigidity of his requirements and testing.

On completion of his engagement with the City of Providence, he opened an office in that city, where he continued to practice his profession. During the years 1878 to 1889 he was engaged in designing water-works plants and sewerage systems for numerous towns and cities.

In 1890 he was appointed city engineer of Providence, R. I., which position he held until 1896, after which he was retained as consulting engineer to the city for two years, when the sewerage system was completed.

As far back as 1880 he was retained in contested cases involving questions of damage due to the taking of water



J. Herbert Shedd.

for public supplies and on the valuation of water-works. Following his retirement from the position of consulting engineer for the City of Providence, his professional work consisted very largely of consultation with reference to various works and expert work for valuations.

In addition to his professional work Mr. Shedd enjoyed service on numerous public commissions. He was appointed commissioner for Massachusetts on the Concord and Sudbury rivers in 1860; member of the Board of Harbor Commissioners for the State of Rhode Island in 1876, of which board he was chairman continuously from its organization to his death; member of the interstate commission to fix the boundary line between the states of Rhode Island and Connecticut in 1885; member of the interstate commission to establish encroachment lines in the Pawcatuck River, 1887; member of the commission for investigating the necessity of a new bridge across the Sakonnet River, Rhode Island, and a member of the commission to build a new bridge, 1904 to 1910.

In 1904 Brown University honored him with the degree of A.M. Mr. Shedd became a member of the American Society of Civil Engineers in September, 1869, and at the Centennial Exhibition was chairman of its subcommittee on sewerage and sanitary engineering.

*Contributed by O. Perry Sarle, Civil Engineer, Providence, R. I.

Analysis of the Failure of an Earth-Fill Dam

By Guy Sterling*

SYNOPSIS—The Hatchtown dam, on the Sevier River in southern Utah, in a most inaccessible location, failed on May 25, 1914. At that time such of the particulars of the failure as were obtainable were published. Since then Mr. Sterling has investigated the design and construction of the dam and has studied the causes of its failure. The results of this investigation are given herewith as a guide for possible future work in earth-dam design.

The Hatchtown reservoir is located on the Sevier River in southern Utah, about 220 mi. south of Salt Lake City, at an elevation of about 7,000 ft. At this site in 1900 a private irrigation company built a small earth dam with a lime-mortar culvert. Soon after its construction this dam started to leak and subsequently was washed out, but reconstruction was immediately started and carried out. In May, 1901, this second dam had been built to a height of 40 ft. and provided, near the middle of its length, with a timber spillway 4 ft. deep and 20 ft. wide, to discharge on the downstream face of the rock fill, which is reported to have withstood a flow corresponding to 1 ft. in depth in the spillway. At this juncture a rising stream, due to the usual spring floods combined with high winds and inadequate spillway capacity, overtopped the dam and, except part of the culvert, carried away nearly the entire structure, although strenuous efforts were made to save the work by opening the culvert gates to full height and raising the crest of the dam. After this failure no further attempts were made by local interests to rebuild the dam.

The next dam to occupy the Hatchtown site and the one to which this article is chiefly devoted, was built by authority of the Utah State Board of Land Commissioners and under the general supervision of the State Engineer, in connection with a state irrigation project embracing about 6,000 acres of land lying below and from 12 to 20 mi. north of the site.

In the summer of 1906, soon after the state had gained control of the reservoir site, surveys and foundation tests were made for the dam. The contract was let and construction begun in August, 1907; it was completed in November, 1908. This third dam was washed out in May, 1914 (see Fig. 2).

Description of Site After the Failure

Fig. 1 contains a topographical map of the site as surveyed after the failure of May 25, 1914, and projected thereon, with substantial accuracy, is the official plan of the dam and the outlet culvert, the spillway being shown as it exists. At the northerly end of the site is the steep face, about 10 ft. high, of a bed of basaltic lava the base of which has practically the same elevation as the top of the dam. Extending northerly under the lava is a bed of gravel about 25 ft. thick underlain by sedimentary rock, of which an outcrop, probably uncovered during the failure, appears just below the dam on the northerly edge of the river, and of which another outcrop, known before the construction of the dam, is exposed on the southerly bank of the river one-quarter mile below.

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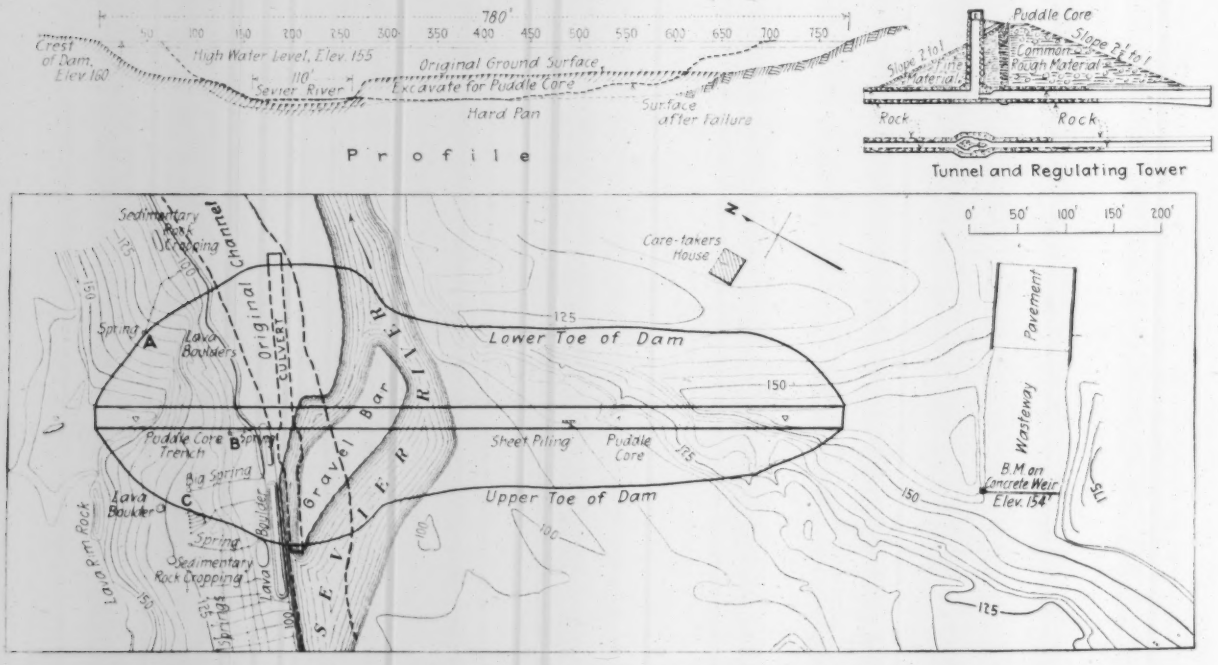


FIG. 1. MAP OF HATCHTOWN DAM SITE AFTER FAILURE AND DETAILS OF DAM

The talus extending southerly from the base of the lava to some distance under the river, on which a large part of the dam was founded, is a heterogeneous mixture of black clay, sand and gravel, on the surface of and embedded in which are many large lava boulders occurring singly and in extensive clusters (Fig. 3). From the gravel was subsequently filled to the present levels as the flood subsided.

From the data available regarding foundation tests at the dam site it is difficult to determine whether the "hardpan," stated in the engineer's reports of the tests to have been found at the site, was a bed of clay or the

FIG. 2. LOOKING NORTHERLY ON AXIS OF DAM AFTER FAILURE

underlying the lava and from the bedding planes of the sedimentary rock at the northerly end of the site, about 5 sec.-ft. of water is discharged by several small streams or springs, but chiefly as percolation or seepage. Of the total flow thus discharged probably one-half comes to the surface under the base of the dam. The assumption is that the greater part of this flow consists of seepage from the irrigation of bench lands north and west of the site. On account of this water, which spreads itself quite generally over the talus, the material of the latter, as it appeared three weeks after the failure, was in a saturated condition, being particularly soft where pockets of clayey sand and small gravel occurred. On the southerly side of the river no lava appeared in place, the material in view and on which the dam was based being entirely different from that in the above-mentioned talus and, in general, part of an extensive stratified deposit of sand and gravel.

Comparisons of the topography and profiles (Fig. 1) of the site made before and after the failure indicate that northerly of the river and upstream of the axis the erosion due to the failure and the ensuing flood was in general limited to the 1 or 2 ft. of original soil not removed in clearing the site. Below the axis and especially near the downstream toe the erosion was greater. Fig. 2 shows the eroded face of a bed of boulders partly embedded in the talus material and extending from a short distance below the axis to the downstream toe of the dam. Southerly of the river the surface of a great part of the base is in general from 15 to 20 ft. below the original surface. Since, however, the outlet culvert and nearly all of the sheetpiling, to be described hereinafter, disappeared from the site, it is probable that during the flood the base under the dam southerly of the river and in the river bed also was eroded to greater depths than are now indicated and sedimentary rock previously referred to, except perhaps on the northerly side of the river, where the rock was probably reached. The records, however, support the conclusion that on the southerly side mud and quicksand were encountered near the level of the river in every test hole sunk, and that satisfactory investigation of conditions below the quicksand was not made.

General Details of Dam Construction

Except when otherwise ascertained and noted the design (Fig. 1) and specifications of the dam filed in the office of the State Engineer must be assumed to represent the structure as it was built. According to the data thus available the main structure, of about 126,000-cu.yd. contents, was an earthen embankment of maximum height 63 ft., crest length 780 ft. and contained a puddle corewall from end to end. The slope of the downstream face was 2½ to 1. The slope of the upstream face for a vertical distance of about 10 ft. below the crest was 1½ to 1, with the remainder 2 to 1. This latter face was paved to a thickness of from 1 to 2 ft. with roughly cubical lava rock, generally of such dimensions and weight as one man could handle. The crest width of the dam overall was designed to be 20 ft., but the width of the remnant still standing is less than 12 ft. About 200 ft. beyond the end of the dam and through the gravel and sand ridge forming the southerly abutment was cut the spillway channel, of 150-ft. width as originally designed, but as built, of 80-ft. width, 5- or 6-ft. depth below the top of the dam and of 160-ft. length, to discharge on the paved slope of the downstream side of the ridge. For regulation purposes the spillway was provided with movable weir boards supported by timber frames.

With the given freeboard of 5 ft. below the crest the capacity of the reservoir back of the dam was 13,000

acre-ft., but with a freeboard of 10 ft. the capacity would be reduced to 11,000 acre-ft.

Located in the river bed about 200 ft. from the northerly end and under the deepest part of the dam were the outlet works, consisting of a single rubble-masonry arched culvert 320 ft. long and 5 ft. wide by 8 ft. high, inside, provided with a reinforced-concrete double-compartment gate chamber opening into and supporting a rubble-masonry gate tower situated upstream of the puddled corewall and 35 ft. from the axis of the dam. The arch of the culvert was semicircular, and 3 ft. thick at the crown; the side walls were 4 ft. thick at the level of the floor, under which the masonry was 3 ft. thick. The culvert and tower were lined with cement mortar 2 in. thick. No cutoff collars, as generally understood, were provided for the culvert.

To regulate the discharge through the culvert one 4x4½ ft. cast-iron gate connected with raising devices

FIG. 3. TALUS MATERIAL UNDER BASE OF DAM
Broken face of dam in background

in the tower was installed in each compartment of the gate chamber. No provision was made for repairing the gates or the upstream part of the chamber when the former were closed and the water stood in the reservoir.

The trench for the outlet culvert was excavated in the talus material in the bed of the river, and as shown in Fig. 1 was for about 130 ft. of its length immediately alongside the remnant of the old culvert before mentioned.

Fig. 3 is a typical view on the northerly side of the old culvert, as it appeared after the failure of the dam. The boulder on which the pick in the view rests and the larger boulder at the right are immediately under the masonry and are in their original places as deposited in the talus, although the clay, sand and gravel originally surrounding them have been eroded. The elevation of the base of the old culvert is about 2 ft. above the normal surface of the water in the river, the annual rise and fall of which is seldom more than 3 ft. The rocks forming the foundation course of the culvert masonry were evidently not tied to the "hardpan" but were laid directly on the talus material occurring in the bottom of the trench. In preparation for the next course of masonry concrete was probably shoveled into the interstices between and on top of the rocks. Whether the trench was adequately drained before the concrete was placed, could not be directly determined. Some evidence on this question is furnished by a large piece of masonry estimated to weigh 18 tons and apparently comprising the floor and base of part of the gate chamber, which was carried about 2,000 ft. below the site by the rush of water following the failure of the dam. The rocks of the foundation course as here shown were partly embedded in a hard concrete, but the projecting parts of the rocks and the interstices between them were entirely open and clean, thus indicating that the rocks as laid were partly embedded in some comparatively soft material and not tied to the sedimentary rock underlying the site.

To prevent the flow of water between the old and new culverts a masonry wall of perhaps 2 or 3 ft. in thickness is reported to have been built between the two structures at each end of the gate chamber. But since the base of the old culvert was 8 ft. or more above that of the new one, and since these walls did not rise much if any above the spring of the arch of the new culvert, they naturally terminated in the talus material on which the old culvert was based. Except these walls nothing in the nature of a cutoff collar was constructed in connection with the culvert. Backfilling of the culvert trench is not mentioned in the specifications, and there is no record as to how this portion of the work was performed.

Construction of Puddle Corewall

The center line of the puddle corewall was located about 20 ft. upstream from and parallel to the axis of the dam. The trench for the corewall was specified to be 15 ft. wide through the length of the dam and excavated to "hardpan" or such material as was satisfactory to the engineer. As indicated in Fig. 1, it was 8 ft. wide at its base, but as exposed at its northerly end (Fig. 5) it was 20 ft. wide. The specifications required the core to be built up in 6-in. layers of fine material containing 18% of clay and not over 10% of stones having maximum dimensions of less than 3 in. After deposition the material in each layer was to be mixed by harrowing with a weighted disk harrow, sprinkled and then tamped by driving horses, cattle or sheep over the layer until the hoofs of the animals should penetrate the surface not more than 1½ in. Subsequent to this tamping and in preparation for the next layer the surface was to receive a light harrowing.

The records of the work do not indicate that any difficulty was encountered northerly of the river in excavating the core trench to a base deemed suitable by the engineer in charge. This part of the base, however, was in the talus material previously described, as is shown in Fig. 3 and in the foreground of Fig. 5. At the intersection of the corewall with the old culvert masonry the latter was removed so that at this point the base of the corewall rested directly on the talus material underlying the

old culvert. On the northerly side of the river and within about 10 ft. of the side of the new culvert the corewall was based on the talus material, and consequently, in connection with other described conditions, it is fairly inferable that the new culvert was based on the same material.

The available records give no information regarding the character of the material encountered in excavating that part of the core trench between the culvert and the original southerly bank of the river. Southward from the southerly edge of the river, however, the trench was apparently carried down through the gravel and sand formation to about the level of the river's surface, when mud and quicksand were encountered, preventing further excavation of the trench by the means at hand. It was then decided to drive timber sheetpiling from the bottom of the trench to "hardpan," which was believed to occur at a depth of 4 or 5 ft. below the level of the river's surface. The sheetpiling consisted of a double row of 2x6-in. plank driven by a 20-lb. maul, without staggering the vertical joints. The piling extended southerly from the river's original edge at least 220 ft., where a small portion of the row is still in place with the tops of the piles about 7 ft. above the surface of the river. The balance of the sheetpiling driven southerly of the river has disappeared. Further interesting information regarding the driving of the sheetpiling is contained in the following quotation from a letter written during the work by the superintending engineer.

> We have driven a double row of about 40 ft. of sheetpiling 4 ft. long after taking down the water about 18 in. in the core trench. We have gotten out of the black clay almost entirely and have instead genuine quicksand. We strike something hard in the bottom which the piles will not penetrate though a bar can be driven down with a sledge hammer seemingly without limit.

From this statement it appears probable that the sheetpiling referred to did not reach the so-called "hardpan."

The corewall remaining northerly of the river (Fig. 5) appeared to consist of backfilled talus material. It lacked firmness, cohesiveness and homogeneity. The remnant of the corewall southerly of the river, about 260 ft. from the southerly end of the dam, consisted of clayey sand, which when dry would break up into hard lumps, but when wet quickly disintegrated. This material was similar to that occurring adjacent to the core trench.

Method of Draining the Foundation

Neither the plans nor the specifications of the dam contain any information as to the work performed in disposing of the previously described flow of water which percolated quite generally throughout the talus material, forming the base of the dam northerly of the river. But it is understood that two and perhaps more drainage ditches running in general transversely to the axis of the dam were excavated in the talus material, and that the water thus collected was conducted in 4-in. tiling across the core trench to the downsteam toe of the dam. Appearances at the site after the failure indicated that the ditches were not excavated to impervious material or were not deep enough to intercept more than a small proportion of the total flow, although they probably received such seepage as occurred in relatively large streams and near the surface. Of these drainage works the remnants of two lines of tiling are all that were seen at the site. The broken end of one of these lines of tiling discharging a stream of water (spring *B*, Fig. 1) appears near the downstream side of the core trench (Fig. 5). In the downstream toe of the remnant of the dam northerly of the river were two caves formed long before the failure and resulting from the escape of spring *A* (Fig. 1) from its tiling. Except the spring *C* (Fig. 1) the springs *A* and *B* were the largest instances of concentrated flow to be seen at the site subsequent to the failure. The spring *C* has a discharge about equal to that of the springs *A* and *B* combined. It issues between large boulders partly embedded in the talus material and is located approximately 20 ft. higher than the river and 15 ft. downstream from the upstream toe of the dam, where the depth of embankment directly over the spring was about 8 ft. The occurrence of this spring may be due to an increase, subsequent to the construction of the dam, in the total discharge from under the lava, or merely to a subsequent local concentration of part of the flow percolating generally through the talus. In any case its disposal was not provided for when the drainage works were built.

FIG. 4. TALUS MATERIAL UNDER BASE OF OLD CULVERT MASONRY

A line of tiling extending from the corewall to the downstream toe was also laid on each side of the outlet culvert.

Method of Making Embankment

It was specified that upstream of the corewall fine material should be used for the embankment, to be built up in longitudinal layers having a uniform thickness of not over 6 in., consolidated by a roller of 1-ton weight per foot of length and prepared for the succeeding layers by light harrowing with a disk harrow. Wetting or sprinkling the layers is not mentioned in the specifications of this part of the work. The downstream portion of the dam was to be built of coarser materials deposited in 1-ft. layers and rolled as specified for the upstream fill.

The embankment upstream of the corewall could not be examined, as it was practically all carried away at the time of the failure. The material remaining in the downstream portion of the embankment was a loamy sand lacking compactness but otherwise suitable for the purpose.

Upstream of the corewall, about 120 ft. in length of the remnant of the old culvert and also the boulders and a piece of the broken-down old arch, which in the course of the work had been piled alongside and on top of the old

masonry, were buried under the dam. The occurrence of a piece of old arch in the midst of the boulders indicates that the positions of the latter were practically the same after the failure as before, although the finer material in their neighborhood had been eroded.

By an earthen dike built across the Sevier River above the site the stream was diverted from its channel and carried to below the site on the northerly side of the remnant of the old culvert, to the lower end of which was added a bank of rock, gravel and earth extending downstream beyond the toe of the dam. Later the stream was carried through the new culvert.

The excavation of the outlet culvert trench and, southerly of the river, the corewall trench and the building of the main embankment were started next and carried on practically at the same time.

In obtaining material for the dam, borrow pits were opened on the southerly part of the site, one pit being located immediately adjacent to the upstream toe and at an elevation of from 30 to 40 ft. below the crest of the dam.

The records clearly show that at times during latter November and December, 1907, the ground at the site was frozen hard and that the superintending engineer desired to protect the culvert masonry from frost, but was apparently unable to do so satisfactorily until practically all of the masonry, except the gate-chamber arches, had been placed, the completion of these arches being in fact postponed on account of the cold weather.

Work on the embankment did not cease until about Dec. 1, although the surfaces of the fill as made each day and when not frozen hard were undoubtedly subjected to the deteriorating effects of alternate freezing and thawing due to the cold nights and the succeeding comparatively warm days usual at the site during latter October and November.

FIG. 5. LOOKING NORTHERLY ON LINE OF CORE TRENCH AFTER FAILURE OF HATCHTOWN DAM

In addition the records show that considerable friction existed between the contractor and the superintending engineer, who during October, November and December of 1907 claimed in substance that the contractor was unwilling to perform the work according to specifications or instructions and not equipped either financially or physically to carry on the construction properly. After the resumption of work in April, 1908, there were apparently no further serious differences between the contractor and the engineer.

Operation and Failure of the Dam

In ordinary seasons the storage of water in the reservoir back of the dam would begin between Nov. 1 and Mar. 1 and continue until the following June 1, the greater part of the water being received during the flood season of April, May and June. About June 1 withdrawal of water for irrigation would begin, and by Sept. 30 the reservoir would be practically empty. Thus in general the dam would have to resist the forces due to full depth of water in the reservoir for a few weeks only each year.

In the spring of 1909, the first year of operation of the reservoir, the mechanism of one or both of the outlet gates became disarranged, and the superintending engineer blew them out from the downstream side with dynamite, but reported that slight damage had been done to the gate seats or the gate chamber.

In the spring of 1910, after the reservoir had been filled, seepage and consequent sloughing of about 200 ft. in length of the downstream toe of the dam occurred at an elevation of from 25 to 35 ft. below the crest and southerly of the river. The sloughing was stopped by placing on the toe a heavy layer of rock. The records, however, do not state whether this stopped the seepage.

The records show that during the winter of 1910-1911 a large part of the paving on the upstream face of the dam was relaid and that repair work was performed on the gates, the assistant engineer in charge reporting that the concrete of the bearings of the gates was of poor quality.

On Apr. 15, 1914, the depth of the water in the reservoir at the dam was 35 ft., corresponding to a storage capacity of 4,900 acre-ft. At this depth only about 275 ft. in length of the upstream face of the dam would have been flooded. May 5 the depth was 41 ft.; on the tenth, 47 ft.; on the twenty-second it was 52 ft. and so remained until the twenty-fifth. At 2 p.m. on this latter date, according to the watchman, a slight seepage that had been previously noticed near the bottom and on the southerly side of the downstream end of the outlet culvert increased to a solid stream of muddy water, described as being of the size of a stove pipe, and probably issuing under some pressure. In about two hours this stream began to increase, and at 8 p.m. great wedges of earth began to slip from the face of the dam over the culvert.

In this manner the embankment was quickly cut back to within about 60 ft. of the crest, when a section of the dam, 30 ft. long on the axis, moved bodily forward, followed by a wall of water 52 ft. in depth. A few minutes later the gate tower fell. The watchman estimated that 75% of the 12,000 acre-ft. in the reservoir escaped during the first hour after the break and that by 11 p.m. the reservoir was practically empty.

FIG. 6. UPSTREAM SIDE OF DAM AFTER FAILURE, SHOWING EXPOSED CULVERT END

FIG. 7. DOWNSTREAM SIDE OF DAM AFTER FAILURE, SHOWING EXPOSED CULVERT END

The failure of the dam was probably the result of a combination of the described conditions, part of which were contributory in their effect, but some of which were so related that a radical betterment of one or two would probably have prevented the inception of the break and thus saved the structure.

Probable Causes of the Failure

(1) The immediate cause of the failure was, without doubt, the lack of cutoff collars on the culvert.

(2) Of first importance as contributory causes were the defective foundations of the culvert and the corewall, the perviousness of the latter and the failure to clear the site of the remnant of the old culvert and the near-by accumulation of boulders.

(3) An increase in the tendency of the water to creep along the culvert probably resulted from the manner and order of building that part of the dam adjacent to the culvert and based on the river bed, and from the weather conditions prevailing during the intermediate stages of the work.

(4) The excavation in the stratified sand and gravel underlying the southerly part of the site, of a borrow pit parallel and near to the upstream toe at a deep part of the dam, would furnish the water a relatively easy path from the reservoir to the body of the dam, thus contributing to the adverse conditions already existing along the culvert.

(5) The uncontrolled part of the water percolating so generally under the northerly base of the dam would tend to saturate the embankment adjoining the culvert, thus further reducing the resistance to creep of water along the latter. This condition, however, is believed to have been only remotely contributory to the failure, since the pressure of the percolating water appeared insufficient to cause the break. This conclusion applies to the spring *C* also, regardless of when it developed, as its low pressure, combined with its issuance near the upstream toe of the dam, would exclude it as one of the primary causes of the failure.

General supervision of the design and construction of the dam was under Caleb Tanner, then State Engineer, who appointed Joseph Jenson and W. W. McLaughlin, of Logan, Utah, engineers on design. This firm, as shown by the records, prepared the plans and specifications of the dam. With the title of superintending engineer, Joseph Jenson of the above firm had responsible charge of the work in the field through the entire period of construction. The contractor for the work was D. W. Brinton, of Draper, Utah.

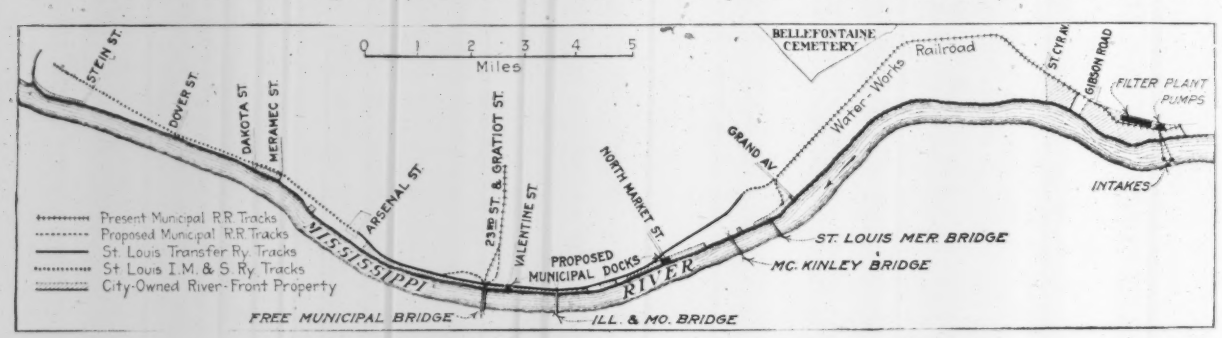
A Private Italian Water-Power Enterprise has been under construction for the past two years near the town of Lucca, in Tuscany. This project, briefly described in "Mine and Quarry" for January, consists of an aqueduct 19,700 ft. in length, which will receive water from the Serchio River. The aqueduct is mostly tunnel, there being two tunnels, one 13,100 ft. long, the other 3,300 ft. in length. The longer tunnel has a portal near Castelnuovo di Garfagnana, while the shorter tunnel is near Gallicano. The Castelnuovo tunnel is designed to be 8x7 ft. in cross-section inside the concrete lining, but the variety of soil encountered caused the section to be changed at a number of points, to facilitate driving and timbering. The soil ranges from soft fire clay to limestone. There is also considerable clayey schist. A bottom heading (6½x6½ ft.) is driven, and the roof is taken down and the tunnel enlarged to full section. One of the headings ran into soft material and required timbering. Harder material was encountered in the other heading of the Castelnuovo. Drilling is done by two Sullivan piston drills, mounted on a heading bar, which put in a round of eight holes to an average depth of 5 ft. In harder rock additional holes were drilled. The order of drilling was as follows: First, the two back holes, looking up, from over the bar; next, the center hole; then the two rib holes, looking up slightly; then the drills were swung under the bar and the three lifters were put in, looking down slightly. Two benzine locomotives are used to haul the muck out of the tunnel. On the shorter tunnel the bottom-heading method is employed also, although a top heading was driven for the first 100 ft. Air is supplied to the drills in the longer tunnel by two cross-compound air compressors located one at each portal. The promoter is the Societa Ligure Toscana di Elettricita, Ltd., of Leghorn. Mario Axerio, of Turin, is engineer. The contractor is Manotti Falzoni, of Milan. The work should be completed by July, 1916.

St. Louis Municipal Railway and Water Front

Unique among cities of the United States through ownership of a large part of its water front, St. Louis is already well started on a project (see accompanying map) which will make it owner of a railroad extending along more than two-thirds of its Mississippi River water frontage, together with a branch inland, the whole totaling about 18 mi. in length. Two municipal docks are proposed, as shown on the map and as was stated in *Engineering News* of Dec. 2, 1915, p. 1101.

The city's first venture in railway ownership was the Water-Works Railroad, 7½ mi. in length. This was completed about 1891, to aid in constructing the Chain of Rocks pumping station, and now gives access also to the large filtration plant put in use in 1915.

A franchise held by the St. Louis Transfer Railway Co. and extending from about the southern end of the city's line to a point about 2 mi. south of the municipal bridge expired. This company is a subsidiary of the St. Louis Terminal Railway Co., and it happened that at the same time, in order to enlarge its yard facilities, the Terminal Co. was applying for permits to cross certain public streets passing through ground which it already owned.



MUNICIPAL RAILWAY AND WATER-FRONT PROPERTY, ST. LOUIS, MO.

After negotiation a temporary permit was issued for these crossings, with the understanding that it must be confirmed by an ordinance and that among the considerations in this ordinance the city would receive the present trackage of the Transfer Railway Co., and the Terminal Co. would also construct a connection between the new municipal bridge and the Merchants Elevated Tracks, which run into the Union Station. This would give the city over 6 mi. of additional trackage, most of which would be in a line extending along about two-thirds of the water front and part of which consists of double tracks.

The city also has the right-of-way and is preparing plans for a line westward from the municipal bridge to meet the Western trunk lines at about 23rd St.

The franchise of the St. Louis Transfer Railway Co. expired about Dec. 15, 1915. The Department of Public Utilities has prepared an ordinance to make effective the agreement described above. All of this work is under James A. Hooke, Director of Public Utilities.

The new docks are to have reinforced-concrete wharf structures, with steel frame warehouses and full mechanical equipment. The first unit, now authorized, will be 300 ft. long out of a total intended length of 1,200 ft. The estimated cost of the work is $285,000.

Tar Coating for Concrete Pipe Under High Velocity*

By Charles H. Paul†

The regulating outlets through the Arrowrock dam are molded in 1:2 portland cement mortar, except for the 28 ft. next the upstream face of the dam, which is lined with semisteel pipe. These outlets are 4 ft. 4 in. in diameter and are subjected to velocities of 60 ft. per sec. or higher. Wood-pipe staves were used for lagging the forms, and great care was used to secure a smooth and straight surface. The upper outlets are 70 ft. in length and the lower ones 130 ft. long. After the removal of the forms they were trimmed, scraped and washed with grout in the usual way, and then they were painted with two coats of water-gas tar and two coats of coal tar—the same combination that has been used for several years for painting metal that is to be subjected to the action of water.

The idea at Arrowrock was not so much that of waterproofing as to fill all the minute voids in the surface of the outlets, so as to prevent if possible the erosion caused by the formation of vacuum in small voids or pockets. Preliminary experiments had indicated that the water-gas tar would penetrate the concrete, and that the coal tar would follow it in and bind to the concrete much better than if it were applied direct, thereby completely filling the voids at and near the surface and coating the concrete with a slick and fairly durable finish, cheap and easily applied.

Behavior of Pipe in Service

This coating was applied to all outlets during the fall of 1914. Five of the lower outlets and six of the upper outlets were in service during the irrigation season of 1915, some of them working for four and one-half months under heads varying up to a maximum of 100 ft., with corresponding velocities up to 64 ft. per sec.

All of them passed through a fairly normal winter and summer. The one that was used most was operated nearly all the time with its valve only partly open, which is a less favorable condition than with the valve wide open. After this service careful inspection was made and the tar coating was found to be in excellent condition. In a few small spots the outer coating had come off, but even there the concrete surface was well filled with the tar and was still well protected apparently against water

*From "Reclamation Record," January, 1916.
†Recently Construction Engineer, United States Reclamation Service; now with Miami Conservancy District, Dayton, Ohio.

action. It is the opinion of the men familiar with all conditions that the use of this tar coating gave thoroughly satisfactory results.

Precautions in Using Tar

In obtaining material for work of this kind it is very important that the water-gas tar be of very thin consistency. The manufacturers can supply it that way if it is made plain to them that this thin consistency is important; otherwise it is likely to come too thick. The manufacturers can also supply an oil for thinning this water-gas tar, and it is advisable to have some of this oil on the job in case it is needed; but it is believed that the success of the whole operation depends upon the very thin, water-like consistency of the water-gas tar. Both the water-gas tar and the coal tar should be refined.

It is necessary to have the concrete thoroughly dry at the time the first coat is applied. The water-gas tar may be applied without heating, and the second coat may follow the first immediately. The first coat of coal tar may be applied as soon as the water-gas tar has soaked in a little, but the second coat of coal tar should not be applied until after the first coat has set. Both coats of coal tar should be applied hot and brushed out as thin as possible, as a thick coating is much more likely to peel and run.

Approximate Costs of Applying Tar

The approximate cost of painting 1,000 sq.ft. of surface in a 52-in. diameter outlet with two coats of water gas and two of coal tar as described herein was as follows:

Labor, 4½ days at $2.50	$11.25
Material:	
12 gal. water-gas tar at 16c.	1.92
15 gal. coal tar at 16c.	2.40
Brushes and miscellaneous	1.43
	$17.00

Cost per sq.ft., say 1¾c.

The refined water-gas tar and refined coal tar were purchased from the Barrett Manufacturing Co. at $4 per bbl. of 50 gal. f.o.b. Chicago. Freight to Boise was about $4 per bbl.

How Co-operative Courses Train Young Engineers

By H. A. Stringfellow*

The writer has read with interest and gratification, the excellent, though all too brief, article by Prof. F. E. Ayer, on "Coöperative Technical Schools," which appeared in the Dec. 2 issue of *Engineering News*. It is aimed here to supplement that article with a paragraph on young engineers as real producers and to give the experience of another school employing the coöperative system in civil-engineering training.

Limited Value of Young Graduate

To say that the graduate of the purely theoretical school is poorly prepared for actual engineering work is to put the case mildly. He is, in the majority of cases, not prepared at all, and in fact has to live down much of his education and training before becoming of value to his employer. He has an education along technical lines that would qualify him ultimately to occupy a high position in the engineering world; but because of his inability to apply this education early he is unfitted to hold efficiently the subordinate positions he must occupy in order to acquire experience. He has been taught to think in large numbers, to look upon a structure as a whole and to overlook the detail operations necessary to its creation. He has slight idea of the value of details, absolutely no knowledge of costs, materials or methods, and no experience to back up his technical training; he is almost valueless to his employer at the start. When put at routine work in the drafting room, where he almost invariably lands upon graduation, he becomes discontented and discouraged because things are so different from what he had pictured them. In many cases he is not even told the use to which his work is to be put. The result is that he becomes of still less value to his employer.

It is the aim of the coöperative system to avoid this condition—this overtraining in theory and lack of training in practice; this unbalanced condition that throws upon his employer the burden and expense of training the technical graduate. It is the object of the coöperative system to turn out men who are producers, small ones to be sure, but who from the start are of value to those who employ them.

Many engineers know in general of the coöperative system, but few have any definite ideas as to how it is operated and its results as regards the students working under it. Such information can best be given by a concrete example.

Coöperative Courses at Rochester

At the Mechanics Institute, Rochester, N. Y., the theoretical work, that is, the work of the classroom and laboratory, is arranged to a great extent upon the same general lines as those followed in engineering schools of the purely theoretical type—with this exception: No courses are given simply for their value in mental or manual training. It must be shown that a certain course has a practical educational value before it is admitted.

Critics of this system will say that it is too intensely practical. Our reply to this is that engineering work is, in its very nature, intensely practical and that such courses have a greater value in mental training because of the fact that the student realizes their value and pursues them with increased interest. As an example we can take the courses in mathematics.

These courses are not given as an end in themselves, but simply as tools to be used in actual work. The problems given are not the vague, pointless propositions encountered in the average text, but bear directly upon actual work. As the student learns the subject, he is taught the practical application of each new theorem or method that he encounters, both by lectures in the classroom and problems to be solved. The result is that when he comes up for his pure-engineering subjects he has a set of tools with the use and construction of which he is familiar.

For work in physics the same idea is followed. In English his work is not confined to themes that simply give him general training in self-expression; he is taught the precise language of specifications, the correct manner of writing business letters, how to prepare a report on a certain engineering project, how to write a technical article.

But it is in the handling of the pure engineering subjects that the greatest value of the coöperative system is to be felt, and the writer will attempt to show the result of the system upon the work of the students.

*Head, Department of Civil Engineering, Mechanics Institute, Rochester, N. Y.

During the first year or so the student is placed on a variety of work, mainly along the lines of laborer or helper. Some care is taken to place him on work in the line of engineering he intends to follow, but this is not of as much importance at this stage of his training as to have him acquire experience in working with men, becoming familiar with their ideas and habits and learning how to hold a job. In many cases he is advanced, by the company who employs him, to an actual engineering position. The writer has men in his senior class, on railroad work, who were advanced from positions as laborers on the section gang through successive positions to that of first-class rodmen. These men during the past two and a half years have been employed in the following departments and at the following classes of work—section gang, road-master's office, work train, material yards, steam-shovel crew, maintenance-of-way department, file clerk, drafting room, location work, Government valuation work.

If the men are so located that they cannot be advanced, their positions are changed during their third year so that their work will be along technical lines. Some men in the civil-engineering department have worked up a small practice in city surveying and divide their working time between this work and work with consulting engineers.

Benefits to Civil-Engineering Students

The result of this training is that the men come to the classroom with a good idea of the practical and economic side of engineering work. They are familiar with structures and machines—they have seen them under construction and in operation. Their sense of proportion is greatly increased, and they can ask intelligent questions.

One proof of the high efficiency of the coöperative system is the much higher grades made by students from such courses in civil-service examinations taken in competition with men from purely theoretical schools. Another proof of efficiency is the quickness with which the men find positions after graduation.

By its results the coöperative system has answered many of the criticisms advanced by practicing engineers against the older methods of technical training. The men have been "broken in" while acquiring their theoretical training. It is not pretended that graduates from schools of this type have great experience in engineering work, but they are experienced in working for and with men, they know the ways of the shop and office, they have some idea of engineering economics, they know the value and necessity of experience in the technical subjects they have studied, and quickly become familiar with the work upon which they may be employed. If the coöperative system does no more than this, it has justified its existence.

Straightening the Great Miami River at Dayton, Ohio

By R. H. Randall*

The Great Miami River improvement, as undertaken by the City of Dayton, Ohio, is a project for controlling and restricting the waters of the Great Miami where it flows through the lowlands in the southern portions of the city. This work must not be confused with the larger plan of flood prevention in the Miami valley, which is being carried forward by the Miami Conservancy District.

The work of straightening the river's channel and reclaiming the large areas subject almost annually to inundation was begun by the city on Sept. 1, 1914, and

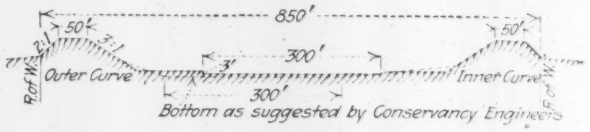


FIG. 1. CROSS-SECTION OF GREAT MIAMI RIVER CHANNEL, DAYTON, OHIO

the construction work, in charge of G. F. Baker, Jr., Assistant Engineer, is now approximately one-third completed and is progressing rapidly. The project is financed by bonds issued in the sum of $450,000 and authorized by direct vote of the citizens of Dayton.

The design of the new channel and levees is shown in the accompanying diagram. A cross-section as shown by the dotted line was proposed by the Conservancy District engineers, deepening the stream bed on the outside of the curve, thereby giving the water at once the channel it would most probably eventually seek, but leaving the amount of excavation the same as in the first plan. This suggestion, however, was not adopted, although the contractors are now permitted to cut down to the channel grade at any place between the inside toes of the two levees. In general the city's plans were approved and

*Assistant Engineer, Department of Engineering, Dayton, Ohio.

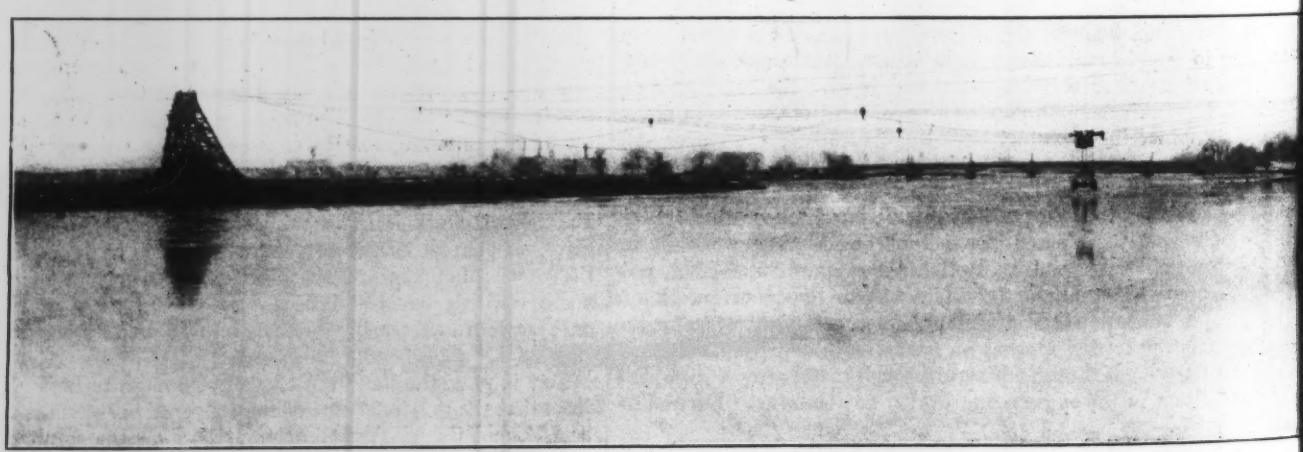


FIG. 2. STRAIGHTENING THE GREAT MIAMI RIVER AT DAYTON, OHIO; EXCAVATION BY TRAVELING

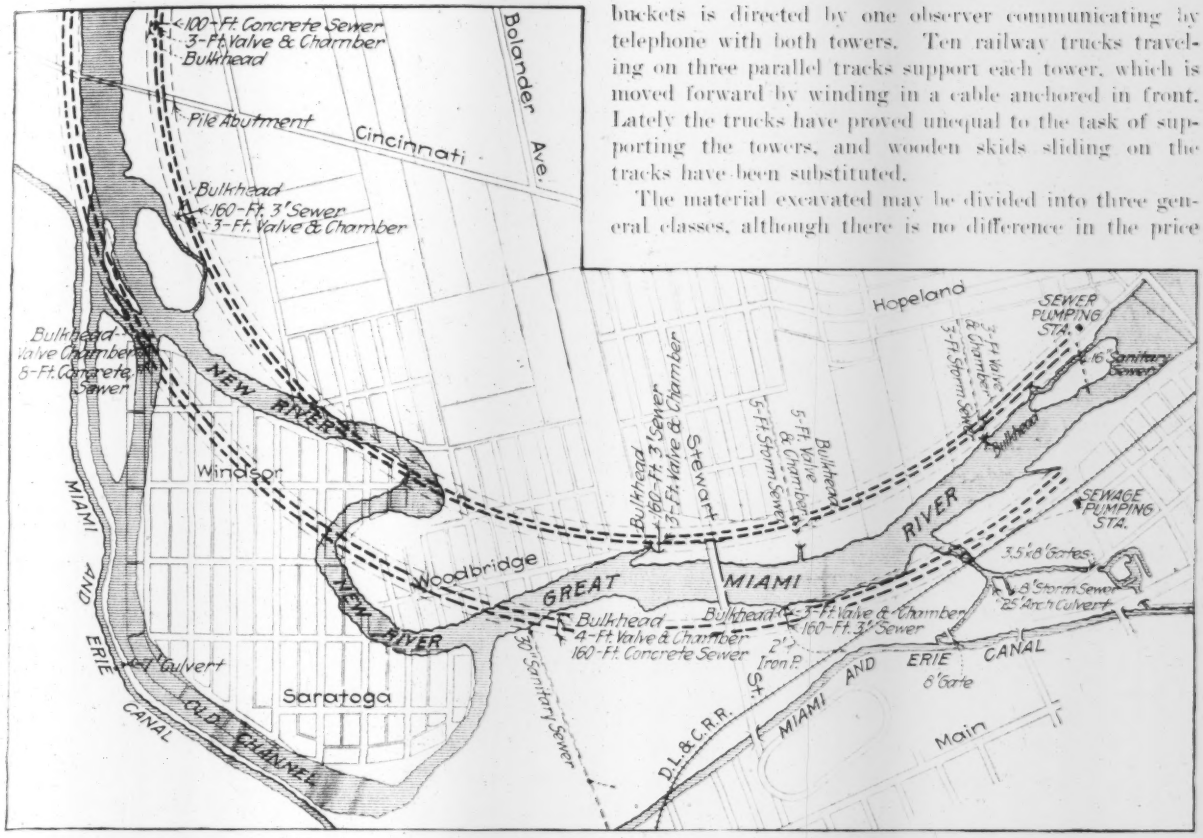


FIG. 3. PLAN OF GREAT MIAMI RIVER IMPROVEMENT UNDER WAY BY THE CITY OF DAYTON, OHIO, AT A COST OF $450,000

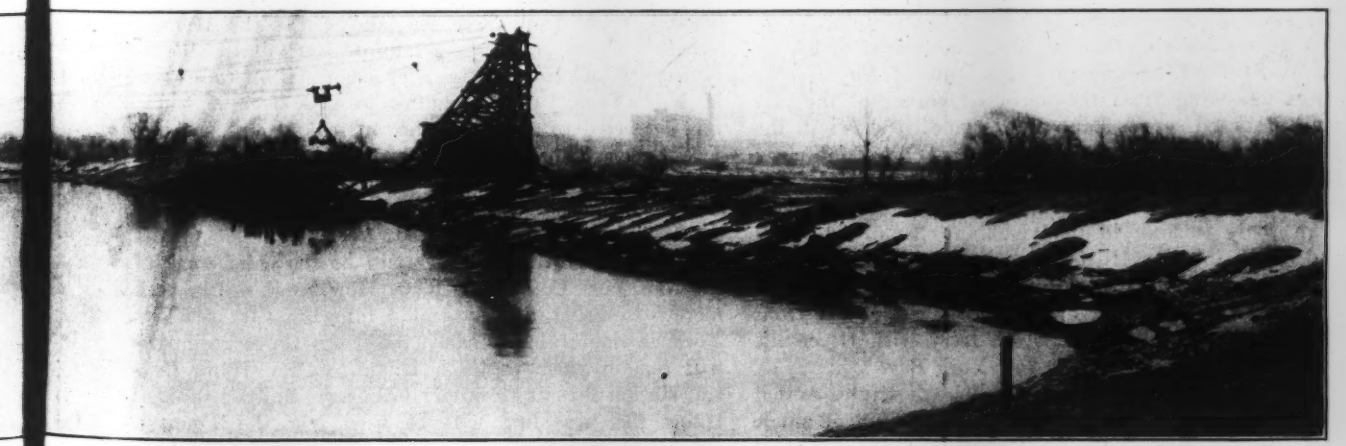
incorporated in the scheme of flood control, after a complete survey of conditions throughout the valley.

Two general methods are employed by the contractors in excavating the channel and building the levees. Wherever possible, the work is done by steam shovel and wagons; but where water is encountered, buckets running on cables stretched across the river are used. The buckets are of the Hayward 2-yd. clam-shell type, controlled by the Lambert system of hoists (see illustration).

The cables are supported by heavy wooden towers on each side of the river. Each tower contains an engine which controls one bucket, and the operation of both buckets is directed by one observer communicating by telephone with both towers. Ten railway trucks traveling on three parallel tracks support each tower, which is moved forward by winding in a cable anchored in front. Lately the trucks have proved unequal to the task of supporting the towers, and wooden skids sliding on the tracks have been substituted.

The material excavated may be divided into three general classes, although there is no difference in the price per yard. On the surface is usually found the river deposit of silt, below this a layer of sand and gravel, and beneath the gravel a deposit of lime conglomerate is sometimes encountered. This last, although troublesome, can ordinarily be broken up and removed by the buckets.

As has been stated, construction work began Sept. 1, 1914. However, on Mar. 25, 1913, the first day of the Dayton flood, the towers were up and everything was in readiness for beginning. After the waters receded, the towers were found still standing, but things were in such shape that neither the city nor the contractors were able to take up the work until eighteen months later.



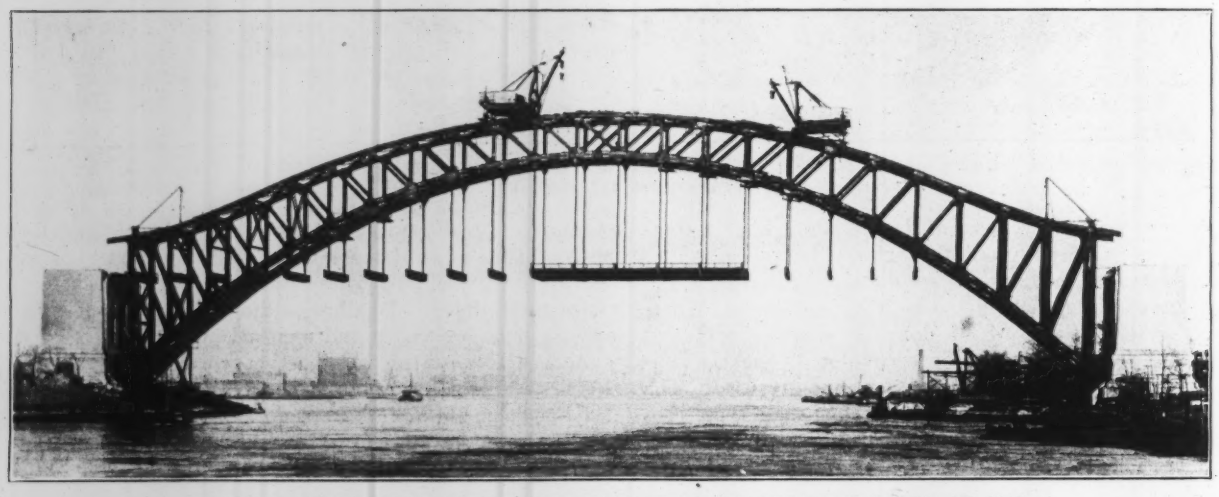
CABLEWAYS; EACH TOWER CONTAINS AN ENGINE WHICH CONTROLS A 2-CU.YD. BUCKET

First All-Rail Through Route Across New York City

[With Inset Sheet]

SYNOPSIS—Origin and history of the New York Connecting R.R., which establishes the first through railway connection across New York City. It also creates a second entrance to the heart of the city from north and east, the only prior one having been controlled by the New York Central since the early days of railways. The new line is enormously costly and includes great engineering works, chief among them the Hell Gate arch.

Well-planned strategy and 30 million dollars, embodied in a railway enterprise of remarkable simplicity and boldness, will in a few months convert New York from a city of terminals to a way-station in the east-coast railway system of the United States. Through trains will run from Boston to Philadelphia—or they may run from Portland to Jacksonville—across Manhattan Island and its two lines of defense, the East River and the Hudson.



HELL GATE BRIDGE ACROSS THE EAST RIVER AT THE BEGINNING OF 1916

The New York Connecting R.R., which will accomplish this revolutionary change, is nearing completion.

A general view of the new line, drawn true to life by E. W. Spofford, accompanies this issue of *Engineering News*. Looking from the northeast corner of the city southwestward across Manhattan Island, it shows in the foreground the main trunk of the New York Connecting R.R. and—at the left border, where the railroad forks into separate freight and passenger lines—the passenger-train route turning to the right into Sunnyside yard and on to the East River tunnels of the Pennsylvania R.R. The freight line, leading off eastward, encircles Brooklyn and in the far distance reaches the waterfront at Bay Ridge, to connect by car-ferry with Greenville on the New Jersey shore of New York Bay.

How great an achievement this line constitutes cannot be realized fully without recalling that for 80 yr. a single interest—the New York Central R.R.—has controlled entrance into New York from the north and the east. Its freight line along the west side of Manhattan Island and its passenger line leading down Fourth Ave. to the Grand Central Terminal effectively barred the way of any other railway that might seek to get into the city from New York State or New England. The New York, New Haven & Hartford R.R. therefore is a tenant in the Grand Central Terminal and brings its freight trains to Port Morris, whence a 15-mi. car-ferry trip is required to reach the New Jersey shore.

Now joining hands with the Pennsylvania, the New Haven outflanks the New York Central and by way of the new bridge-and-tunnel route not only reaches the heart of the city but continues with direct track connection to the west and the south. Instead of crossing over to Manhattan at the Harlem River frontier, the point of easiest attack, this flanking line takes the bold and difficult route via the East River islands and the Long Island shore.

The preëminent distinction of the new line is not so much its entrance into New York as its creation of a through route from New England across the Hudson barrier. Every passenger heretofore has felt the inconvenience of making the transfer from station to station in New York. Corresponding to this, freight traffic was subjected to a large surtax in making the transfer across the gap between the Bronx and the New Jersey yards, or the reverse. The inconvenience for the passenger will now be removed, and the added cost for freight transfer will be greatly reduced.

This through-traffic service will be the chief work of the New York Connecting R.R. How far it will be used merely to bring railway traffic into the City of New York is doubtful; probably the New Haven company will remain permanently a tenant in the Grand Central station for its passenger business. But for through trains the new line will be used, via the Pennsylvania station. Similarly in the matter of freight traffic: The existing yard and handling facilities will doubt-

less continue to take care of the terminal business, and the work of the new railway will be to handle the through business.

While the plan of operation has not been divulged by the railway men concerned, the fact is well established that the line will carry freight traffic chiefly. For each passenger train which the railway will take across the East and the Hudson rivers, probably a dozen freight trains will go to or from the Bay Ridge yard.

Not only the Pennsylvania R.R., but also the Lehigh Valley, the Central of New Jersey and other railways terminating on the west side of the Hudson will exchange their freight with the New Haven and its New England connections over this route. The freight traffic, in fact, is what will pay the interest on the many million dollars of bonds issued to build the line.

An Enterprise of Enormous Cost

As a problem of design and construction, the New York Connecting R.R. can hardly be compared with other railways. It stands by itself. Its key structure is a bridge of unprecedented proportions—a four-track steel arch nearly a thousand feet in span, crossing the dangerous tidal channel of Hell Gate. There are four or five other bridges of notable character, and fully four miles of viaduct, heavy and monumental.

That this construction is costly work needs no remark. The four-mile section which is now nearly ready to carry traffic has cost roughly 15 million dollars—practically 4 millions per mile. These figures represent the top notch in cost of transportation lines. What hitherto has been considered the most expensive type of railway in existence, the rapid-transit subway in a congested city district, is cheaper by one-third than the new Connecting railroad.

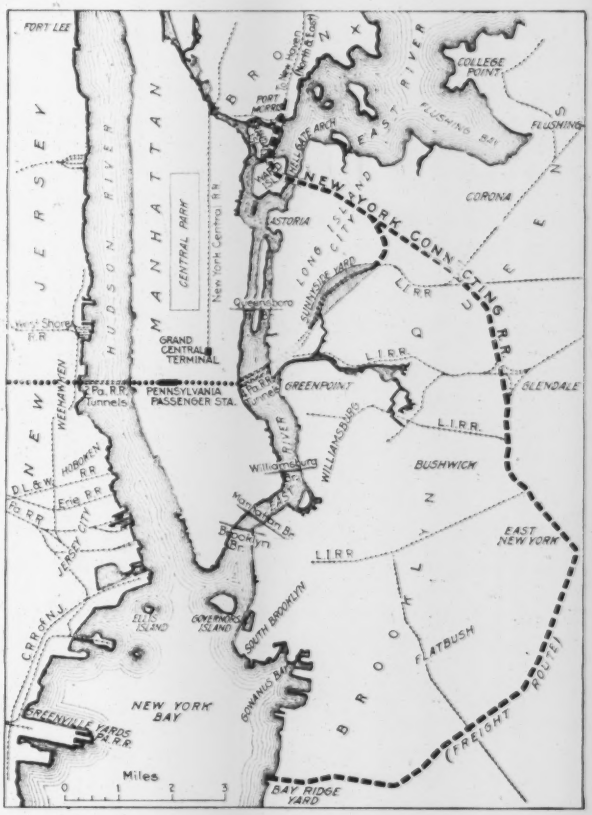
But the money so far spent is only half the final cost. When the whole line, including the freight connection, is completed the total expenditure will be 30 millions. A net income of a million and a half dollars must be earned each year to pay the interest on this vast sum!

The Project Nearly 25 Years Old

Though the great cost and the boldness of the project stamp it as a modern enterprise, yet it was conceived a quarter-century ago. It was associated in the beginning with two other remarkable construction schemes, one of which has since been realized. The first was the project for a Hudson River suspension bridge, planned in the early nineties to carry the traffic of all the railroads terminating on the New Jersey shore over into Manhattan—by way of a 2,800-ft. span! The other was the Steinway tunnel project, to connect New York with Long Island City across the East River about the line of 42nd St.

Men of both enterprises saw the connection between their schemes and realized that by their combination it might be possible to bring Pennsylvania R.R. trains over to Long Island. Austin Corbin, of the Long Island R.R., O. W. Barnes, promoter and engineer of the original Steinway tunnel, Samuel Rea, of the Pennsylvania, and Gustav Lindenthal, the suspension-bridge engineer, were leading figures in the schemes. Some of them, looking even beyond the New Jersey-Long Island idea, saw the possibility of linking the system up to the New Haven railroad, using the islands in the East River as stepping-stones from Long Island to the Bronx. A reconnaissance was made, the outlines of the project sketched far enough to estimate its feasibility and cost, and the preliminary steps were taken toward making it a future reality. A franchise was secured by Barnes. Later, Boller & Hodge, engineers, made another set of plans.

When in 1900 the Pennsylvania R.R., having just taken over the Long Island R.R., suddenly threw its energies into the New York station scheme and started the construction of tunnels under both rivers, the Hudson bridge project had to be dropped, and it has been dormant since that time. But the Connecting railroad with its Hell Gate crossing remained a live element in the general

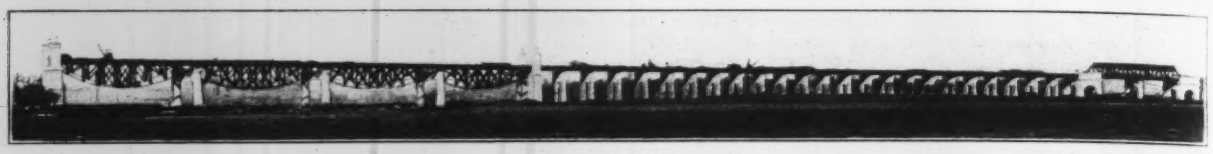


MAP SHOWING NEW YORK CONNECTING R.R. THROUGH NEW YORK CITY

scheme. Waiting on the progress of the tunneling, it was not put forward to an active stage until 1906 and again—after being shelved by the stringency of 1907—in 1912.

Samuel Rea and Gustav Lindenthal have stayed with the Connecting railroad project from its earliest days until now. The former, president of the Pennsylvania R.R., is also president of the New York Connecting R.R., and its guiding spirit. The latter is chief engineer of the line, and as such has set himself as striking a monument as if the huge Hudson River suspension bridge had come to be built.

The bridge and viaduct portion of the line, extending from 142nd St. in the Bronx four miles to Sunnyside yard, comprises the difficult work of engineering and construction. Three miles of it consists of steel spans on concrete piers; the easterly mile is fill retained between high concrete walls held together by tie-rods.



VIADUCT SECTION OF NEW YORK CONNECTING R.R. BETWEEN HELL GATE BRIDGE AND THE BRONX MAINLAND
Little Hell Gate Bridge to the left; Bronx Kills Bridge to the right; steel viaduct in middle

This latter portion, the Eastern Viaduct, is new in type of design as well as in execution. With a maximum height of 65 ft., it would have required very heavy walls but for the ingenious device of tying across with rods (2¼-in. rods spaced 10 ft. apart vertically and horizontally) so that the concrete walls are mere slabs that hold the earth in the 10-ft. panels. Even so the results would have been clumsy if ordinary methods of filling had been employed. By placing selected fill in thin layers and tamping it with pneumatic rammers, a consolidated fill was obtained whose pressure against the walls is relatively slight; and to make the condition permanent in spite of water, drain wells of dry stone were built every 10 ft. along each wall. By these means it was possible to get along with very thin concrete walls.

The calculations for this structure were given in full in *Engineering News* of May 6, 1915, p. 886.

The Hell Gate Arch, Largest in the World

A span of 995 ft. 1⅜ in. between centers of bearings, a rise of 220 ft. from skewback to soffit, topped off by a 40-ft. crown depth, and a four-track solid-floor deck with reinforced-concrete slab carrying ballast-and-tie roadbed, are structurally the defining facts that make the Hell Gate crossing the largest arch and one of the two heaviest bridges in the world—weighing 52,000 lb. per lin.ft. From another standpoint, however, it is just as prominently characterized by its highly successful æsthetic design, resulting from the collaboration of Mr. Lindenthal and the noted architect Henry Hornbostel. Men of æsthetic appreciation have called it the most beautiful bridge in America—which means at least that the design is good.

General drawings and typical details of the arch were presented in *Engineering News*, Jan. 8, 1914, p. 59, and during last summer the progress of erection was recorded in these columns by numerous photographs.

The American Bridge Co., the largest organization of its kind anywhere, found the construction and erection of the bridge an undertaking that taxed its facilities. Work in the shops began late in 1913, with new, specially devised methods and equipment. In March, 1915, the first steel was erected. After a season of fast, systematic work, on Oct. 1, 1915, the arch was closed. By the successful transfer on that date from the cantilever condition of erection to the arch condition, which made the structure permanently secure against accidents of construction, the builders accomplished the formidable part of their task.

Before steel erection began, however, great difficulties had been encountered in securing the foundations. The west, or Wards Island, abutment proved to be so located—as the result of misleading borings—that rock was from 60 to 120 ft. below ground, shelving down away from the arch. The simple foundation originally planned for had to be converted into a most complex group of pneumatic caissons, sunk to rock and keyed together to make an integral mass.

Details of Viaduct and Bridges

Two other river bridges are included in the East River crossing. The Little Hell Gate bridge, between Wards and Randalls Islands, is for its size quite as individual and interesting as the large arch. It has four skew deck spans, of 292½ ft. each. The engineer chose the inverted bowstring form, a type of truss that had disappeared from bridge practice. Using a 50-ft. center depth and two trusses for the four-track width, the chord stresses were very heavy. The bottom chord is a chain of eye-bars, and for these the largest bars ever made were secured—16x2⅜-in. bars with 16-in. pins.

The bridge crossing Bronx Kills to the mainland at Port Morris is designed as a trunnion bascule, but is built for the present without counterweights and machinery, these to be added later when called for. It has two 175-ft. leaves, meeting on a middle rest-pier; they are through spans, with Pratt-type trusses 45 ft. deep. Caisson foundations for the piers had to be sunk to a depth of 90 ft. below mean low water.

The long stretch of steel viaduct is made up of spans generally 60 to 90 ft. long—though there are 130-ft. spans—set at heights of 30 to 120 ft. above ground.

BRIDGE OVER POTTER AVE., IN ASTORIA, AND A PORTION OF THE CONCRETE RETAINING-WALL VIADUCT
Potter Ave. bridge has three spans on rocker posts; one end fixed

Most of the girders are 8 ft. deep. In all cases there are eight girders, braced together in pairs, forming in effect four single-track bridges.

Throughout, the floor is made of four reinforced-concrete slabs (or troughs) in which a 14-in. depth of ballast will carry the track.

The whole undertaking requires 90,000 tons of structural steel, besides 5,000 tons of reinforcing steel used in concrete. There is 450,000 cu.yd. of concrete. The arch bridge alone contains 19,000 tons of steel.

PRINCIPAL DATA OF HELL GATE ARCH

Span—1,016 ft. 10 in. between tower faces; 995 ft. 1⅜ in. between centers of bearings; 977 ft. 6 in. center to center of end hinges.

Arch—height from center of end hinges to center of top chord, 140 ft. at ends; 260 ft. at center. Height to center of lower chord, 220 ft. Greatest height above mean high water, 310 ft. Clearance above mean high water, 135 ft.

Towers—height above ground, 240 ft.

Width, 93 ft. between centers of railings; 60 ft. between centers of trusses.

Bottom chord, 6½ ft. wide, 11½ ft. deep at ends, 7½ ft. deep at center; maximum section, 1,384 sq.in.

Heaviest single piece, 185 tons (shipping weight 150 tons).

Load—the arch carries four tracks on ballasted concrete floor; total dead-load, 52,000 lb. per lin.ft. of bridge; assumed live-load, E60 on each track.

Material, high-carbon steel.

Rivets—heaviest, 1¼-in. diameter, 10-in. grip (field rivets).

Gusset plates—largest, 10x17½ ft. by 1⅝ in.

End shoes are of cast steel and weigh 275 tons each.

Arch trusses were assembled at the shop for drilling holes for field connections.

Arch erected by cantilevering from both ends, each half being held by temporary backstay trusses which carried heavy counterweights at the rear ends. Larger part of backstay material forms part of the permanent structure.

The towers—of reinforced concrete with granite facing architecturally treated. Long Island tower founded on rock in open cut 20 ft. deep. Wards Island tower rests on 21 concrete caissons sunk under air pressure to rock at a depth of from 58 to 120 ft. below ground surface. Total masonry in towers, 110,000 cu.yd.

Maintenance Records; Concrete Roads in Michigan

The annual report of the Board of Supervisors of Wayne County, Michigan, for the year Oct. 1, 1914, to Sept. 30, 1915, contains some interesting data on the cost of maintaining the famous Wayne County concrete roads, some of which are now seven years old. The boast is made that with 125 mi. of concrete road to date it has never been necessary to take up and replace as much as a 25-ft. section. With 45 mi. more road to maintain, a sum of $5,178 less was spent for maintenance in 1915 than in 1913.

Maintenance and repair work which was required has been promptly performed. This consisted principally of cleaning out and refilling expansion joints and the repair of pockets of inferior concrete caused by clay or some other foreign material getting into the mixture. Usually no maintenance is required during the first year.

Outfit and Work of Maintenance Crew

The maintenance crew consists of seven men. A team and a tar kettle complete the outfit. The foreman is paid $5 a day; the driver with his team, $5 a day; tar-kettle man, $3; two laborers, $2.50 a day each; and two laborers, $2.25 a day each. The tools consist of several wire-bristle brooms, a wheelbarrow, a couple of shovels, a tar bucket and sprinkling cans. Two men are utilized to sweep all cracks or spalled joints clean with the wire brooms, after which the man with the tar can fills the cracks with tar heated to 225 deg. F., allowing it to stand for a few moments to prevent it from bubbling. The tarred cracks are then covered with clean coarse dry sand, spread with a shovel. Pit holes are similarly treated. An excess of tar and sand is used, and traffic is allowed to iron out the surface. The tar used is a special mixture of Tarvia A and Tarvia X.

Where an imperfection in the concrete exists, which does not extend through the road but is over an inch in depth, the hole is cleaned out and carefully dried; it is then painted with hot tar, after which it is filled with stones of suitable size graded to fill the voids as nearly as possible. The stone is tamped or rolled into place. Hot tar is then poured over the patch, the quantity being gaged so that the tar will be taken up by the remaining voids without any large excess being left on the surface. Coarse dry sand is then spread over the patch with a shovel. Holes of lesser depth and any joints from which the filler has wholly or partly disappeared are treated the same as cracks and defective joints. The maintenance crew covers from 1 to 3½ mi. of road per day, and one trip over the work yearly is usually all that is necessary. In 1915 the maintenance crew went over the entire concrete mileage by the middle of August.

Attempts to Maintain Bituminous Carpet

There are 2 mi. of concrete road where the entire surface is covered with a bituminous carpet. The same mixture of Tarvia is used for maintaining these 2 mi. Instead of sand, washed and screened pebbles are used. It is necessary to resurface about one-third of these 2 mi. annually, in addition to touching up spots here and there throughout the entire season. The method followed has been to sweep with wire brooms the spots to be treated, after which the tar is applied. The pebbles are then spread over the tar from wheelbarrows or a wagon and left for the traffic to embed in the tar. The surfaces of these roads become wavy under traffic and are said to be not as desirable as a plain concrete wearing surface, either from the standpoint of the comfort of the user or of economy in maintenance.

Some repairs have also been made which were two or more inches deep, by cleaning out the holes, painting them with a cement grout and filling the cavity with a concrete mixture of the same proportions as that used in the construction of the original pavement; for these the concrete is mixed to the same consistency, as nearly as possible, as that of the original construction. The repaired portion is cured by being kept wet for at least seven days and protected from traffic until thoroughly hardened.

A Railway in Panama, in the Province of Chiriqui, is under construction and will be completed in May. According to a description of the new line, by John E. Tiedeman, in the bulletin of the "Pan-American Union," the railway will have a total length of 62 mi. extending from a port on the Pacific at Pedregal, 300 mi. north of the city of Panama, up to the head of the Caldera valley at the foot of the Chiriqui volcano. In a distance of 33 mi. from the sea coast the railway attains an elevation of 4,500 ft. The district penetrated is subject to heavy rainfalls during the rainy season, the average at David being 34 in. per month. This makes the culverts, bridging and drainage for the line very costly. Heavy rock ballasting is necessary to hold the roadbed. Maximum grades on the line are 5%, but such heavy grades are exceptional, most of the inclines being on a 3% grade. The track is 36 in. gage and the total cost of the line will be about $1,760,000.

Huge New Orleans Screw Pump Shows 80% Efficiency

Two articles are presented on the tests of the first of eleven 12-ft. motor-driven screw pumps discharging storm water from the New Orleans drainage system. The first article, by Prof. W. H. P. Creighton, of Tulane University, describes the conduct of tests which showed a pump efficiency of 76 to 80%—compared with 70% expected. The second, by George G. Earl, General Superintendent of the Sewerage and Water Board, discusses the great improvements in carrying off storm water secured by the characteristics of the new pump, which is better adapted to the work in hand than are ordinary centrifugals.

Testing the 12-Ft. Wood-Nordberg Pump

By W. H. P. Creighton*

A test was made to determine the amount of water that one of the new New Orleans drainage screw pumps could lift, and the efficiency of performance. The results show that the pump raised 559 cu.ft. per sec. through a height of 5.6 ft., and 519.8 cu.ft. per sec. through 7.6 ft., the pump making between 75 and 76 r.p.m. and the efficiency varying between 76 and 80%. The specifications required a maximum deliv- - of 550 cu.ft. per sec. through a lift varying from 5 o 9 ft. when the motor was making 75 r.p.m. The efficiency expected was 70%. It is readily seen that the pump complies with these requirements. High efficiency was maintained over varying lifts.

*Dean, Department of Technology, Tulane University, New Orleans.

The pump tested is one of 11 similar units installed or to be installed in the various drainage stations for pumping the storm drainage of the City of New Orleans. These pumps, as noted in *Engineering News*, Jan. 15, 1914, were designed by the Sewerage and Water Board of the City of New Orleans (George G. Earl, General Superintendent, Alfred Raymond, General Manager of Drainage) under the immediate direction of A. B. Wood, Mechanical Engineer of the Board, who holds patents covering this type of pump. The stations containing these pumps are designed and built under the same supervision. The pump castings and parts were manufactured and erected by the Nordberg Manufacturing Co., of Milwaukee, Wis. The motors were manufactured and installed by the Allis-Chalmers Manufacturing Co., of Milwaukee, Wis.

There was a great deal of trouble in obtaining suitable conditions for this test. The only way, however, to obtain conditions under which the water discharged could be measured by certainly accurate and universally credited methods was to run the test with a gradually decreasing level of water on the suction side of the pumps. Accordingly the greater portion of the test was conducted with levels on the suction of the pump, giving less submergence of the suction intake, and materially lower than would exist in actual operation, and with a condition of water and of approach to the suction intake less favorable for good pump efficiency than that which will exist when these pumps are doing the work which they are built to perform.

The object of this test was to measure the cubic feet of water the pump could lift from one level to another and to find out the efficiency of this operation.

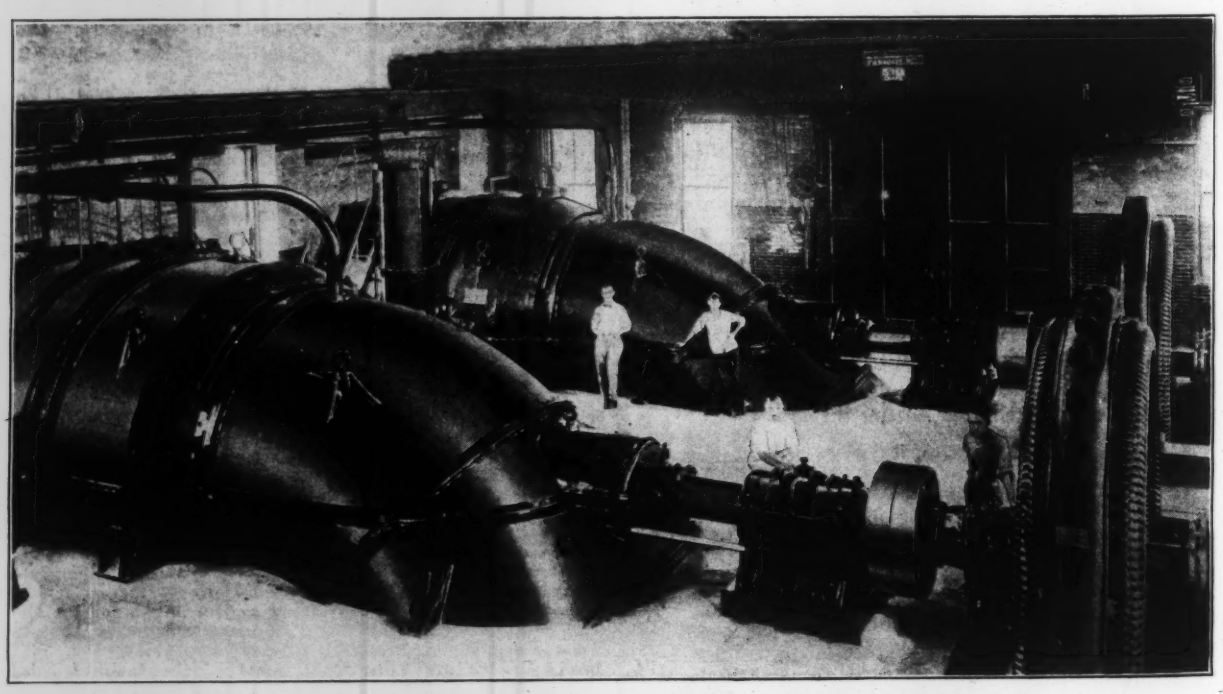


FIG. 1. TWO 12-FT. SCREW PUMPS IN DRAINAGE STATION 1, NEW ORLEANS

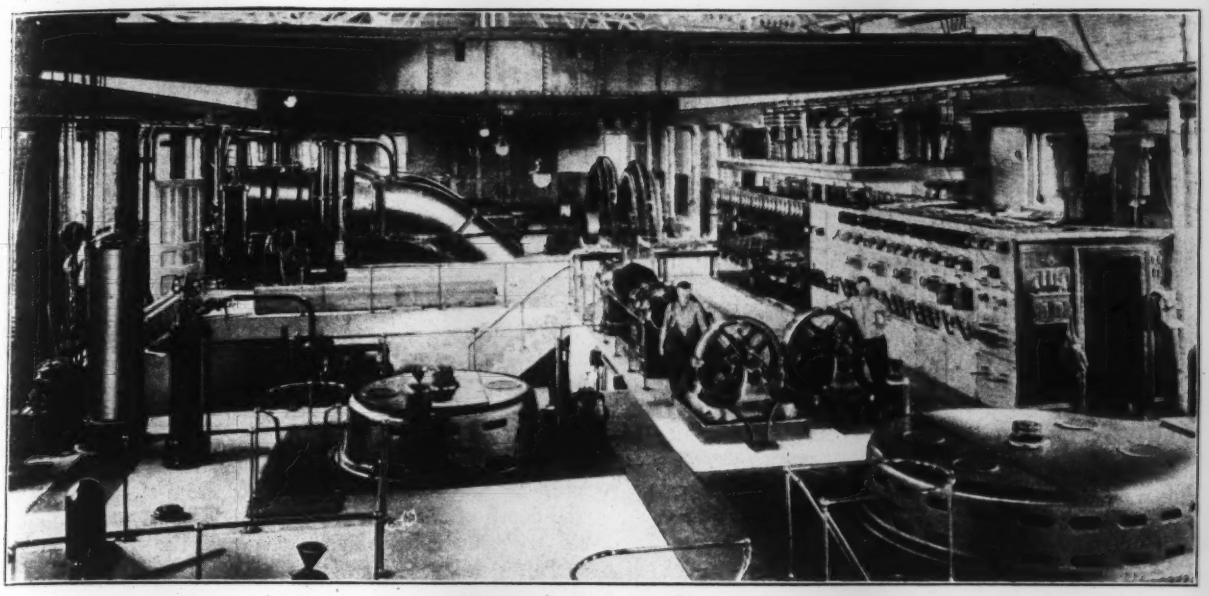


FIG. 2. INTERIOR OF NEW ORLEANS DRAINAGE PUMPING STATION 1

The pump tested is in drainage-pumping station No. 1, at the intersection of Broad and Melpomene St. Two canals lead into the suction basin of this station—one in Broad St., and the other in Melpomene St. The discharge from the station can go either wholly or in part in either of two directions—down Broad St. to drainage station No. 2, (this canal is not yet finished), or out Melpomene St. to drainage station No. 6, the direction being controlled by the hydraulically operated swinging gates shown on the general plan.

The pump proper (Fig. 1) consists of a cylindrical casing, 12 ft. inside diameter and 13 ft. 9 in. long, lying with its axis horizontal and containing the impeller and the stationary or diffusion blades. The diffusion blades are mounted on a water-tight, cone-shaped housing, within which is located a self-aligning main bearing and a marine-type thrust bearing. The inner cone is 8 ft. in diameter at the largest section and is reached through an oval-shaped, water-tight manhole and passage opening through the top of the pump. In this way this inner cone or chamber is at all times accessible for an inspection or adjustment of the bearings, even during the operation of the pump.

On the suction side the pump is connected to a cast-iron 45° bend, through which the shaft, provided with the proper stuffing-box, extends. Between the stuffing-box on the pump and the motor there are another bearing and a flexible coupling. The 600-hp. motor driving the pump is a three-phase 25-cycle 6,000-volt synchronous machine, with an amortisseur field winding.

The part of the suction pipe beyond the cast-iron 45° bend is built up of riveted sheet steel and increases in cross-sectional area, being 15 ft. in diameter at the lower end. The discharge pipe is made of riveted sheet steel, bolted to the pump casing. It contains a 45° bend and sections of uniformly increasing diameter, that of the lowest being 15 ft.

The pump-shaft center line is 2½ ft. above the operating floor of the station. The suction and delivery ends being always under water, the pump is primed by exhausting the air after the motor is in operation.

The total electrical energy input into the armature of the motor was measured by the two-wattmeter method. The true readings were derived from the calibration curves as sent by the maker's laboratory. The electrical input into the field was measured by voltmeter and ammeter (millivoltmeter with 200-amp. shunt). True readings were taken from calibration curves sent by the Electrical Testing Laboratories, of New York City.

The gage to read the elevation of the water in the suction basin consisted of a float chamber of 12-in. cast-iron pipe, set vertically and provided with a float and rod with a pointer. The pointer moved against the gage board, marked off in feet and tenths, and set so as to read the elevation of the suction basin in feet (Cairo datum).

The level of the water in the discharge basin was read on a gage board, graduated to read elevation (Cairo datum) in feet and tenths, and set accurately as to elevation on the inside of a stilling box. On the general plan (Fig. 4) are shown the positions of the discharge and suction gages and also the swinging gates used to regulate and control the head in the discharge basin. The head given in the log is, therefore, the actual head from suction-basin level to discharge-basin level.

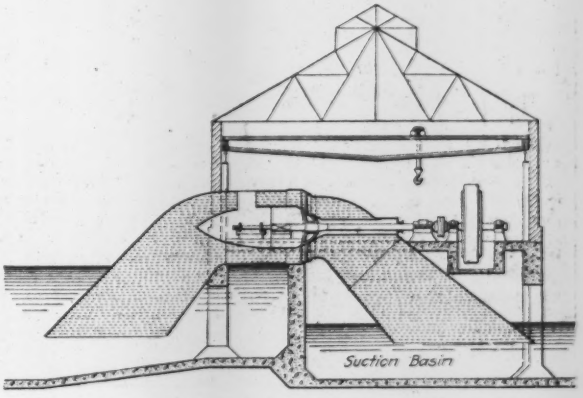


FIG. 3. SECTION THROUGH 12-FT. SCREW PUMP

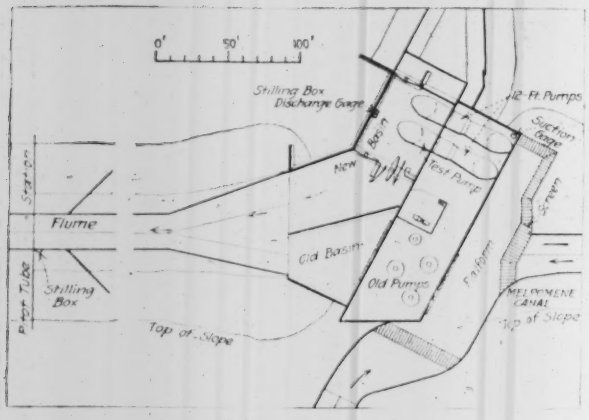


FIG. 4. PLAN OF DRAINAGE PUMPING STATION 1

The velocity of the water in the canal on the discharge side was determined by pitot-tube readings. The tubes used in this test had been used by the same observers on numerous other tests and have been frequently checked against reservoir displacement. The static and velocity water columns are brought to a common reading board, provided with a movable brass scale, graduated so as to read velocity in feet per second.

The discharge canal is of the general section shown in Fig. 7. About 600 ft. beyond the station the woodwork of the canal sides was built up to make a flume, timber lined on sides and bottom, with wing walls to form the approach. The cross-section of this flume also is shown in Fig. 7, and through it the discharge from the pump has to pass. Across this flume, above the level to which the water would rise, was placed a 6x12-in. timber to be used as a bridge, from which the pitot tubes were set, supported and read.

The lower section of the canal (below the line *X-Y*, Fig. 7) is triangular. This triangle was considered as divided into eight sections of equal area, and the pitot tube held at the center of gravity of each of these sections while reading. This tube was called the "long tube," because it had to be extended vertically in order to reach the lower points from the bridge. The average of these eight readings gave the mean velocity of the water in this section of the canal.

The level of the water in the flume was not constant, so a stilling box was fitted to the side of the flume and connected to the flume through a pipe. The level of the water in the flume was then read in this stilling box by means of a hook gage, so graduated that it gave the depth of the water in the rectangular part of the flume (Fig. 7). The velocity of the water in this part of the canal was read with a second pitot tube, exactly similar to the other, but with shorter vertical water-column connections. This was called the "short tube." This rectangular section of the canal was considered as made up of ten sections of equal area, and the tube held at the center of each rectangle when taking a reading. The average of these ten readings was taken as the mean velocity of the water in this section of the canal. The depth at which this pitot tube was set was determined from the readings of the depth of water in the rectangular part of the flume, as shown by the hook-gage readings, the tube point set at half the depth of this water.

Method of Conducting Pump Test

Before the test, all wire connections were checked to insure all instruments reading in the correct direction. The setting of the suction and discharge-head gages was double checked with an engineer's level. The cross-sectional area of the flume was measured with a steel tape. Finally the watches of all observers were set exactly together, the pump was primed and the test started.

Simultaneous readings of electrical input, field current, suction gage, discharge gage, the depth of water in the flume, were made every 2½ min. The water readings were taken by starting from one side of the flume and working toward the other, reading each point in order. One observer with the long tube would go first, reading the lower points in order, followed immediately by another observer with the short tube, reading the upper points in order. A third observer recorded the readings and the time of readings. As soon as the trip across had been

FIG. 5. DISCHARGE OF ONE PUMP OVER AND THROUGH RUDDER GATES

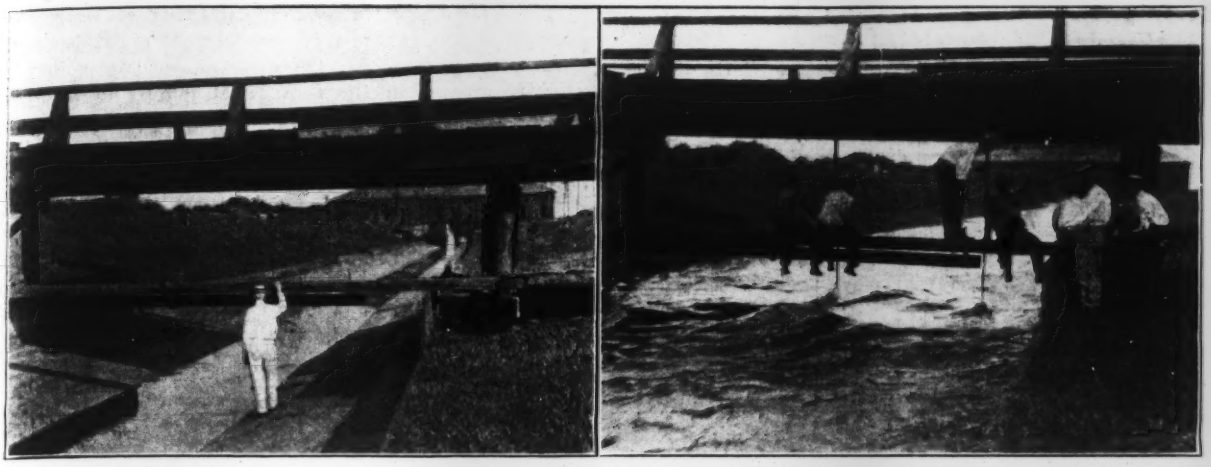


FIG. 6. CANAL AT MEASURING STATION; DRY AND DURING PUMP TEST

made by each tube, constituting one set of readings, another set was taken by going back across in the opposite direction, reading each point in the reverse order. In this way six complete sets of observations were taken, and from these the quantities of water pumped were calculated.

Corrections for Test Conditions

As the test could not be made under normal conditions of operation, certain artificial conditions had to be created. The water on the suction side of the canal was allowed to accumulate by not pumping daily. To secure the necessary lift, the gates controlling the direction of discharge from the new discharge basin were almost entirely closed, so that an artificial discharge head in the basin of any desired height could be obtained by increasing or decreasing the opening of the gates.

Under these artificial conditions, when the water on the suction side was higher than on the discharge side, there was 1.83 cu.ft. per sec. leakage through all the gates and valves of the old station. When conditions are reversed, the amount of leakage becomes uncertain, but it is certain that it could not be less.

A more important correction, which, however, could be quite accurately measured, arose also from the artificial conditions necessary. The water was discharged into an empty canal 3 mi. long. As the length of the water flow increased, the head necessary to cause flow at the pump end increased, which resulted not only in a constant increase in the area of the water cross-section at the measuring platform 600 ft. from the pumping station, but also in a reservoir of water of increasing volume, which had been discharged from the pump and did not pass the measuring station during the time the pitot-tube traverse of this cross-section was being made. This reservoir effect was considerable until the pump at the other end of the canal was started and the water level of the canal assumed a nearly constant slope.

In like manner, as the level of the water in the new discharge basin back of the controlling gates varied during each run, a correction had to be made for this change of volume. This correction was small during the first part of the test, but was considerable near the end, as the discharge basin was being lowered to maintain a nearly constant head on the pump.

The output of the motor was obtained by substracting the total losses in the motor from the total input. After the test the motor was uncoupled from the pump and run light with the same field and at the same speed, to determine the core loss, etc.

The motor efficiency guaranteed by the manufacturer was 92½%. Just after the official pump test, the motor efficiency was calculated as just described and found to be 94.3%. As certain very small losses, called "load losses," could not be measured from lack of sufficient apparatus, the efficiency under test conditions as found by the manufacturer—94.0% and 94.07%—was used in calculating pump efficiency instead of 94.3%. The results of the test are summarized in the accompanying table.

SUMMARY OF TEST ON 12-FT. WOOD SCREW PUMP
Sept. 27, 1915

R.p.m.	Input to Motor, Hp.	Efficiency of Motor, %	Input to Pump, Hp.	Water Levels—Suction	Water Levels—Discharge	Total Head, Basin to Basin	Flow, Cu.Ft. per Sec.	Water Hp.	% Efficiency Combined, Basin to Basin	% Efficiency Pump, Basin to Basin
75.8	494.7	94.00	465.0	14.903	20.475	5.572	559.09	354.0	71.6	76.1
75.2	515.5	94.00	484.6	14.347	20.358	6.011	541.29	369.7	71.7	76.3
75.0	549.4	94.07	516.8	13.654	20.340	6.686	529.79	402.5	73.3	77.9
75.0	589.2	94.07	554.3	12.903	20.300	7.397	516.92	434.5	73.7	78.4
75.5	597.7	94.07	562.3	11.989	19.600	7.611	519.80	449.6	75.2	80.0
75.5	597.8	94.07	562.4	10.801	18.392	7.591	510.08	440.0	73.6	78.2

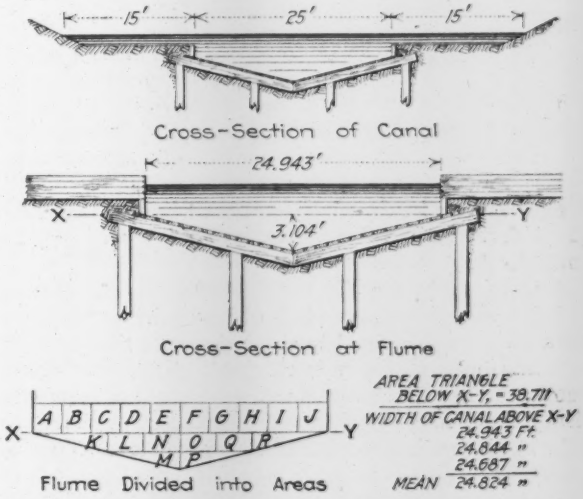


FIG. 7. DISCHARGE CANAL AND FLUME SECTIONS

As a number of preliminary tests had been made, the observers were well trained for their duties. Much credit is due to Technical Engineer S. G. F. Haas, who had charge of all preliminary tests and who worked up the results of the test; to Assistant Engineer Louis T. Frantz, who had charge of electrical calculations and observations; to all of the observers of the Sewerage and Water Board staff and to the student check observers who aided the writer in supervising the test.

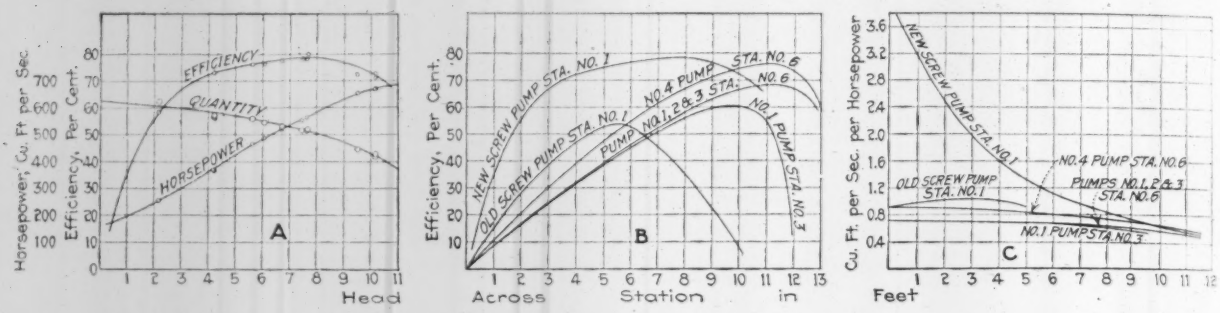

Horsepower; Cu. Ft per Sec.
Efficiency, Per Cent.
EFFICIENCY
QUANTITY
HORSEPOWER
A
Head
Efficiency, Per Cent.
NEW SCREW PUMP STA. NO. 1
OLD SCREW PUMP STA. NO. 1
NO. 4 PUMP STA. NO. 6
PUMP NO. 1, 2 & 3 STA. NO. 6
NO. 1 PUMP STA. NO. 3
B
Across Station in Feet
Cu. Ft. per Sec. per Horsepower
NEW SCREW PUMP STA. NO. 1
NO. 4 PUMP STA. NO. 6
OLD SCREW PUMP STA. NO. 1
PUMPS NO. 1, 2 & 3 STA. NO. 6
NO. 1 PUMP STA. NO. 3
C
Feet

FIG. 8. COMPARATIVE PERFORMANCE CURVES OF NEW AND OLD DRAINAGE PUMP AT NEW ORLEANS
A—Efficiency, delivery, and power curves of Wood screw pump. B—Efficiency-head group for five pumps. C—Head-specific delivery group for five pumps

What the Wood-Pump Test Means to New Orleans

By George G. Earl*

The new screw pumps of the New Orleans Sewerage and Water Board give their best efficiency at 7- to 8-ft. lift and show a better figure for 7½ ft. than the best of the board's old centrifugal pumps at its best point—11-ft. lift. But the advantages of accessibility, operation, first cost, etc., are more than sufficient to dictate use of the screw pumps even if their power-consumption characteristics were the same as those of the centrifugals.

These points, however, I will pass for the present, since it is the significance of the vastly different curves of characteristics which Mr. Wood has obtained in these pumps to which I particularly desire to call attention. The improvement is apparent in the examination of the diagram of comparative-efficiency curves (*B* in Fig. 8). It seems to me, however, that the local benefit is better illustrated by comparing the cubic feet per second discharged per applied brake horsepower for the 75 r.p.m. screw pump and for the other groups of pumps.

The best of these pumps, measured by this yardstick, adds only 50% to its capacity per applied brake horsepower as its lift drops from its point of maximum efficiency, which is 11 ft., down to 0, while the new screw pump increases its capacity per applied brake horsepower 300% from its lift for maximum efficiency at 7½ ft. down to 0.

A centrifugal pump for low lifts with the best characteristics will maintain about $\frac{5}{10}$ of its maximum efficiency for a range of lifts equal to about $\frac{6}{10}$ of the lift at which said maximum efficiency is obtained. These new screw pumps for low lifts maintain $\frac{8}{10}$ of their maximum efficiency for a range of lifts approximately $1\frac{2}{10}$ times the lift at which such maximum efficiency is obtained.

The tendency to increase the quantity of water discharged at constant speed of operation as the lift decreases from point of best efficiency exists in both types, but is slightly greater in the centrifugal pump; to do this, however, the centrifugal pump frequently requires a constantly increasing applied brake horsepower, with the result that its power requirements must be applied with an especial view of meeting the overload, which its lack of efficiency at its lowest lift produces. The new screw pump, on the other hand, when operating at a constant speed shows a rapidly decreasing power demand as its lift decreases, and while it still maintains an increasing discharge, it only uses its maximum power at its maximum lift.

In a system, like that in New Orleans, operated electrically with power and pump capacity designed to give the required output under those low-lift conditions which require the greatest quantity of discharge, the power requirement to operate all units will be much less with screw than with centrifugal pumps. Since as the lift increases, the available flow approaching the stations decreases and fewer pumping units have to be operated, the power required to operate the pumps at a low lift will still suffice to operate enough units as the lift increases to take care of the decreasing flow. With pumps driven by power units capable of some speed variations, the characteristic of the screw pump is such that available power can be utilized at an increased speed at lifts far below the rated lift, without the serious sacrifice of efficiency which an increase of speed entails with centrifugal pumps.

Experience of Sewerage and Water Board

The function of a drainage-pumping station is to maintain the water level on its suction side lower than the water on its discharge side. When it has just ceased to do this, it becomes an obstruction instead of an asset, and its crucial test is its capacity to discharge more and more water with less and less power per unit discharged as the lift decreases and the necessity to pump therefore is most urgent. At the most crucial point, if the power and the pumping capacity are properly adjusted, one will be able to pump with the same power expenditure from three to five-times as much water per applied brake horsepower with pumps having the characteristic of these new pumps as with pumps having characteristics like those indicated in the diagram for the earlier pump installations in New Orleans—or with the best design of centrifugal units.

*General Superintendent, Sewerage and Water Board, City Hall Annex, New Orleans.

The experience heretofore of the Sewerage and Water Board has been that during great storms when lifts were much below the rated lifts, the older forms of pumps overloaded their motors and also overloaded the power stations, so that all pumping-station units could not be maintained in service. With the 11 additional screw pumps and less than enough additional power to operate them at their rated lift, because the flow at rated lift can never supply all pumps, this condition will be reversed. The decreasing amount of power required to operate the new pumps as their lift decreases will more than compensate for the excess amount required by the old ones when their lift decreases and the necessity to pump is at its greatest.

With six great pumping-stations at which the maximum run-off from storms arrives at varying time intervals ranging from a few minutes to about 1½ hr., the matter of increasing the power output of the generating stations from, say 1,000 hp. to over 12,000 hp. and starting up pumping units as fast as the approaching flow will permit is a difficult and vital one.

In actual operation, therefore, the new screw pumps will be started first, as soon as the water approaching the station is sufficient to supply them, because whether the first lift is at above or below the rated lift their flat efficiency curve will give a less absorption of power per unit of discharge when power is being accumulated and is at a premium. After all the screw pumps are in operation, if the approaching water warrants, the other pumps will be started. If the approaching water is in excess of the capacity of all pumps at rated lift, the water level on the approach side will rise faster than the level on the discharge side, the lift will decrease and the power saved by the decreased power consumption of the new pumps will suffice to keep the old ones in operation until the required rate of pumpage is not in excess of the capacity of the new pumps, when the old pumps will be stopped and the new ones continued in operation, because they not only pump the increasing lift due to the exhaustion of the suction water more efficiently, but they are capable of pumping it to a much lower level, that is, through a higher lift than the old pumps.

Advantage of Pump at Siphon Summit

The placing of a screw pump at the summit of a siphon instead of submerging it, as appears to have been the usual practice, makes it accessible for maintenance and avoids the necessity for the very expensive gates required to give accessibility to submerged screws. Where the pumps are operated by synchronous motors, it also avoids the necessity for large and very costly check gates to prevent backflow in case the motors go out of step, which check gates in the older installations in New Orleans have proved not only high in first cost, but very expensive and difficult to maintain in good condition.

Further, in order to start the submerged pumps of the older installation with synchronous motors, it was necessary to have telephone communication with the power station and to slow down an engine and bring the pumps up to speed gradually, and when in synchronism to throw them over the operating bus. This was a tedious and delicate operation, not always successfully accomplished on the first trial, and much time was lost in its accomplishment when time was of utmost importance.

In designing the new extensions it was recognized that the new pumping units must be as large as possible, and their method of starting more simple and certain than that before described if they were to be of the greatest possible use. By adopting screw pumps we had precedent for much larger units than have ever been built in centrifugals, and by setting these screw pumps in the summit of a siphon we are enabled to start them in an empty case by the mere throwing in of a switch, after which the air is exhausted from the pump case and the pump takes its load gradually without any telephoning to the power station or any chance of being put out of step.

Improving the Old Drainage Pumps

There are only two attendants on watch at one time at any of the drainage-pumping stations. Owing to this improved method of starting and to friction clutches that are being built to connect between the old pumps and motors, which will permit these pumps also to be started by the throwing of a switch to start the motor when disconnected from the pump and the subsequent gradual application of the load through the friction clutch, it will be far easier for the operating forces to handle the stations after their capacity has been more than doubled than it was before. At the inception of storms as the flow approaching the station increases, it will be far more easy to start the necessary pumps required to keep pace with such increasing flow than it has been heretofore.

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

Writing engineering reports is being taken up in the new courses of the Massachusetts Institute of Technology on engineering administration. The scheme is to give out an engineering problem to the students (third-year men) and require a report which may be in the shape of a technical article, popular story or concise outline with details in appendices, after the style of formal reports.

The date of the dedication of the new Technology buildings in Cambridge has been fixed as June 14, 1916. This is in Commencement Week. The Chairman of the Dedication Celebration Committee is C. A. Stone.

The stonework of the initial structures is practically completed. Interior floors are being finished. Rough plumbing is all in place and installation of fixtures is under way.

Brown University

Arrangements have been completed for the regular admission at mid-year as well as in September of new students, candidates for the degree of A.B. and Ph.B. The new plan goes into effect in February, 1916, at the beginning of the next semester. Brown is the first of the New England colleges to meet the increasing demand from the mid-winter graduates of high schools and academies that they be allowed to enter college without six months' delay. To facilitate admission the university will hold a special set of entrance examinations prior to the opening of the second semester. Examinations conducted under the supervision of the College Entrance Examination Board and certificates issued by schools having that privilege will also be accepted. No extensive change in the present system of continuous year courses in the curriculum has been made, a special schedule for the new students being arranged which will allow them to fall in with the general program the following autumn

Field and Office

Model Roadbuilding Plant of a Kentucky County

Fayette County, Kentucky, of which Lexington is the county seat, is reputed to have established a remarkable record in road improvement, begun in 1896 by the purchase of toll roads for $352,000. Two years ago it was decided to do the roadbuilding with county day labor and county-owned equipment rather than by contract. There are about 385 mi. of roads in the county system, all but five of which were originally surfaced with waterbound macadam.

The county has a centrally located supply station of 400 tons' capacity. Sand, stone, cement and asphalt are brought in railway cars. The asphalt is stored in steam-heated reservoirs having a capacity of 24,000 gal. There is a warehouse for storing cement, machinery, etc. Stone is obtained from 13 quarries, owned by the county but operated by contractors. There is a central crushing plant operated by inmates of the county workhouse. From the crushing plant the stone is transported by freight cars to the central supply station and unloaded by gravity into concrete storage bins from tracks overhead. There are eight sand and stone bins, each of 50 tons' capacity, which are emptied by gravity through a traveling chute (see Fig. 1).

The other county-owned equipment includes a White "good roads" truck, a White pressure asphalt distributor, two 4-cu.yd. Troy trailers (Fig. 3), an elevating grader, a scarifier, two road rollers, two concrete mixers and a rotary broom. With this equipment and a force of 20 men the county during the last season rebuilt 22½ mi. of old macadam, built 30 concrete bridges and culverts, laid 8,000 ft. of culvert pipe and distributed 80,000 gal. of asphalt in the surface treatment of 25 mi. of roads. As

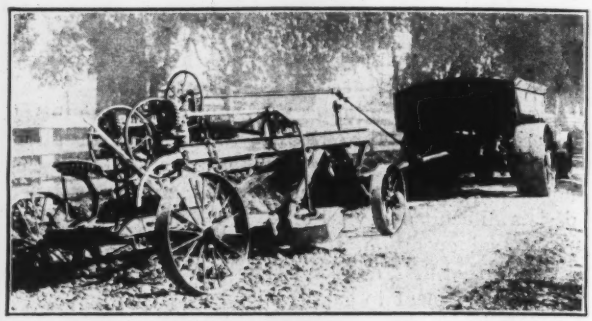


FIG. 2. MOTOR TRUCK HAULING GRADER ON FAYETTE COUNTY ROAD WORK

an example of the efficiency of the present system, it is said that a concrete bridge on which the bids from contractors varied from $750 to $1,100 was built by county day labor under the supervision of the County Engineer for only $400—a comparison which shows not merely saving of profit but efficiency of work.

In 120 working days, May 1 to Oct. 31, the truck and trailers hauled 5,882 tons of stone—an average rate of 49 tons per day, for an average distance of 4 mi., at a cost, including operation and maintenance, of $9 per day, 18.4c. per ton or 4.6c. per ton-mile. The truck was fre-

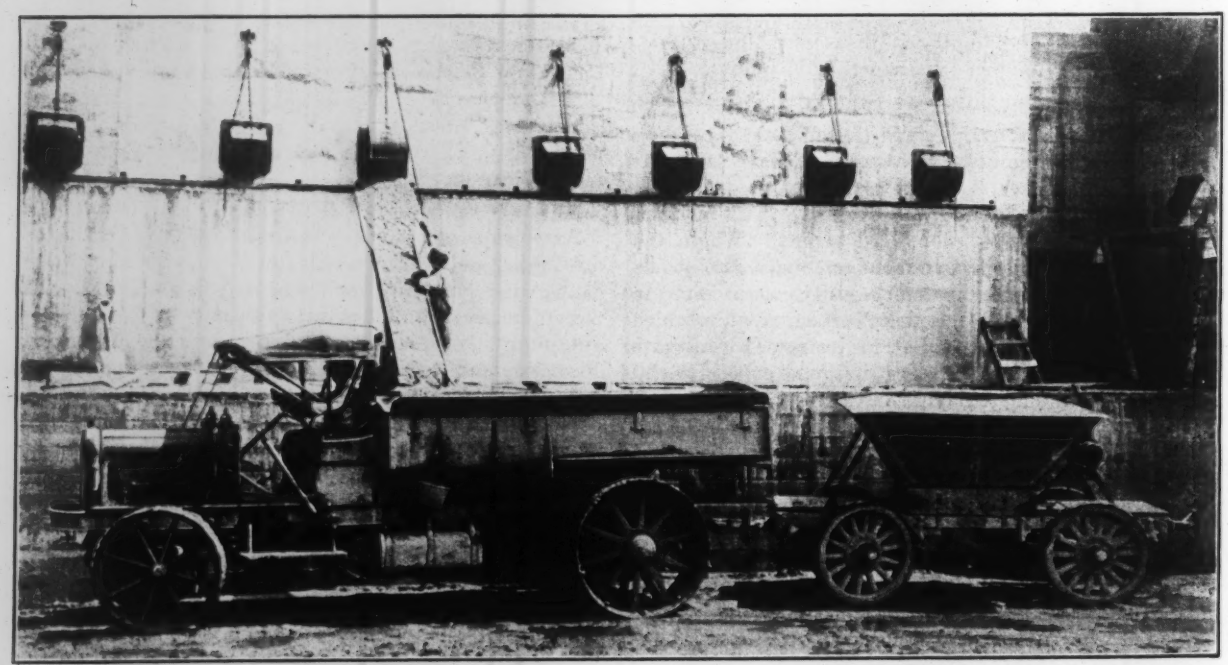


FIG. 1. CENTRAL SUPPLY STATION: CONCRETE STONE AND SAND BINS EMPTIED BY TRAVELING CHUTE

FIG. 3. HAULING STONE FOR FAYETTE COUNTY ROADS, KENTUCKY

quently used to pull a scarifier and occasionally to draw the elevating grader as well as a common road grader (Fig. 2).

Fayette County embraces about 370 sq.mi. and has a population of 56,000. The county engineer is Robert W. Davis, Lexington, Ky.

Laying a Monolithic Brick Pavement in Car Track

Bricks laid on a mortar bed on a concrete foundation that completely incases the steel ties and a part of the rails is the form of street-pavement construction adopted for Tuscarawas St. W., Canton, Ohio. As T-rails are used, special nose brick are laid at the gage side for the wheel flanges. Wood ties were used on parts of the track because access to the car barns and summer-resort traffic would not permit the interruption of the car service necessary for this type of construction.

After the old track was removed and the excavation completed, the rails were bolted to the steel ties, the track brought to grade by blocking under the rails, and the concrete (1:3:5, with gravel aggregate) was poured in one operation to form a monolith slab inside and outside of the rails.

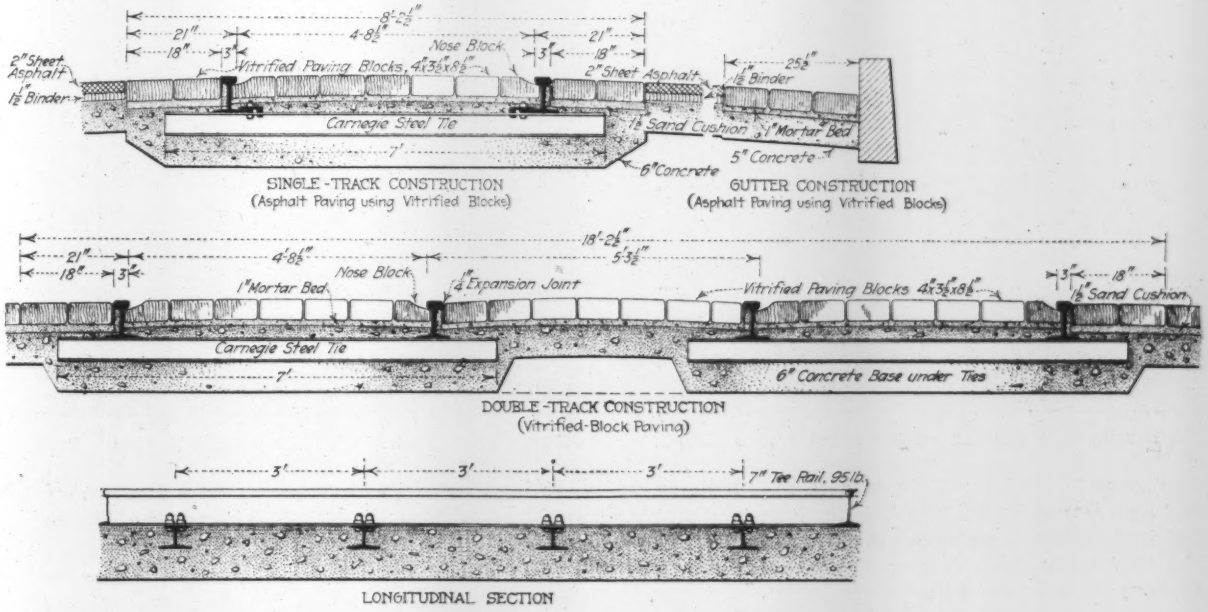
No traffic was allowed for ten days after the concrete was placed. Where there was only a single track, traffic was maintained by means of a portable track laid upon the old pavement and provided with cross-overs. No traffic was allowed during the laying of the brick pavement nor until the grout filler had set.

Where there were double tracks the brick pavement was laid on one side at a time—on one track and the devil strip simultaneously, the cars being operated on the other track only. The running of the cars on the one track did not appear to affect or disturb the grout filler on the devil-strip side, apparently because of expansion strips along the outside of the rail, which took up the vibration in the track.

Where wood ties were used a dry-mixed concrete was thoroughly tamped under and around the ties and under the rails. There is to date no evidence of any movement in the brick surface where steel ties were used, but as was expected, there is some movement where the wood ties were used.

The brick (wire-cut-lug) were laid $\frac{1}{4}$ in. below the top of the rail, to avoid the hammer of car wheels. This does not in any way offer obstruction to the passage of wheels of either slow- or fast-moving vehicles; in fact, the small amount of jarring experienced by the occupants of vehicles passing at all angles over the tracks has been commented upon.

These street-car tracks carry interurban cars weighing about 35 tons. The same type of construction is used



BRICK-PAVED STREET-RAILWAY TRACK CONSTRUCTION, CANTON, OHIO

in Canton on all street-railway tracks being reconstructed or on new tracks, except where only city cars are used. Here T-rails weighing 85 lb. per yd. are used instead of 95 lb. as were used in this particular case.

The street-railway company does all the work except furnishing and placing the mortar bed and wearing surface. The cost of the brick paving in the street-railway area was $1.26 per sq.yd. The excavation cost 40c. per cu.yd. The city engineer of Canton is W. E. Sarver.

Steel Pipe Lasted 22 Years

By E. G. Markley*

In the fall of 1893, Milton Flory, owner of a grist mill in the then village of Bangor, Penn., built a steel intake pipe and installed a turbine to take the place of an open millrace and waterwheel, as well as to make way for certain municipal improvements and eliminate occasional losses due to overflow from the race.

The distance from the dam to the mill was about 3,200 ft. To build the pipe, about 700 sheets of steel $\frac{3}{16}$ in. thick by 5x8 ft., and 96,000 rivets were required. The material was regular boiler steel, purchased from the International Boiler Works. The rivets were heated in a hand furnace and driven by hand at a local machine shop; six sheets were riveted at a time and the 30-ft. section was delivered to the laying point. A gang of seven men laid the pipe on blocking placed in the bed of Martins Creek. About 90 ft. of pipe was placed each day.

The steel pipe has made a remarkable record when it is considered that it was half submerged and constantly exposed to the weather. The creek has its source in the springs of the Blue Mountain, some 10 or 15 mi. distant, and tests chemically pure with a trace of sulphur.

Traces of deterioration began to appear in the pipe in 1907 in the form of small corrosion holes. These were promptly plugged, but in 1912 the seams began leaking and general deterioration began; numerous plugs and bands were placed each year. At some points no attention was given the leaks, and during the winter months great mounds of ice would accumulate along the pipe, as illustrated. The steel pipe was placed at an expense of about $9,000. Today a 36-in. wooden pipe replaces the steel at a cost of $6,000, and it is the hope of the owner that it shall supply water to his mill for at least 40 yr. The static head today is about 44 ft., with a pressure of about 20 lb. at the mill.

*Secretary, S. Flory Mfg. Co., Bangor, Penn.

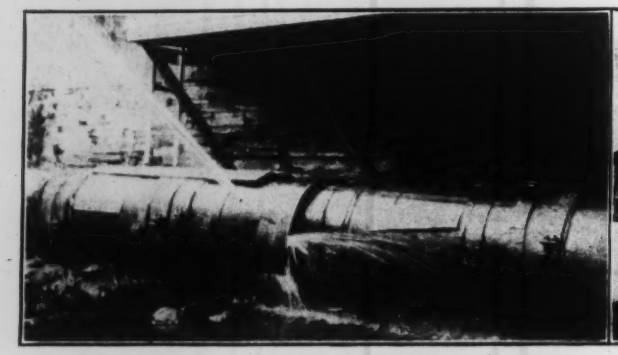


FIG. 1. REPAIRS ON FLORY PIPE, AND A LEAK

FIG. 2. WINTER SCENE ALONG LEAKY STEEL PIPE

An Adjustable Building Shore

The shores shown in the accompanying view are of a type patented by H. W. Roos, of Roos Bros., contractors of Cincinnati, Ohio, and have been used successfully in a number of concrete buildings. Their special feature is

BUILDING SHORE ADJUSTABLE AS TO HEIGHT

the ease with which they can be adjusted to heights between 8 and 16 ft.

The lower section of each shore is a 4x4-in. stick, 8 ft. long, to the top of which are spiked 2x4-in. pieces that serve as guides for the two 2x4-in. struts which make the upper 8-ft. section. Along the sides of the lower 4x4 are nailed 1-in. channels, the outstanding legs of which have been sawed to form ratchet teeth that engage the band-iron tongs fastened to the lower ends of the 2x4-in. sticks.

In operation the tongs grip the ratchet teeth when the upper strut is under load, so that the control of the shore is automatic. Each shore weighs about 60 lb.

Ditching and Grading Machine

A Bowman ditcher and grader is used by the Norfolk Southern R.R. for clearing roadbed ditches, widening fills and trimming the slopes of cuts. Machines of this make have been used by the Southern Pacific Co. and the Missouri, Kansas & Texas Ry. with uniformly good results. On the Southern Pacific the ditcher in a single month handled 22,320 yd. from 8,650 lin.ft. of ditch, at a cost of about 6½c. per yd., to which was added 3½c. per yd. for the work of shifting signals and cattle guards, dressing the ballast and trimming the ditches and carrying them away from the ends of the cuts. In 18 mo. this machine averaged 8,720 cu.yd. per mo. at a cost of 15c. per yd., or 20c. including repairs and the miscellaneous work just mentioned.

The machine is a 50-ft. steel flat-car and is equipped for four kinds of work—excavating side ditches, plowing hard material, spreading dumped material and dressing the slopes of cuts. All operations are controlled by compressed air supplied from large reservoirs, which are charged at 100 lb. pressure by three brake pumps on the car. Steam for these pumps is taken from the locomotive. The weight of the machine complete is about 70 tons.

The car carries two steel gallows-frames, each supporting two jib cranes with 4-yd. scraper buckets suspended in a bail and handled by two vertical air cylinders. In soft material the bucket will fill to about 5 yd. The larger cylinder, 24x60-in., operates the hoisting chains, while the other, 12x60-in., operates the dumping chain attached to the rear of the bucket. With the machine in place and ready to start, as in Fig. 1, the two forward buckets are lowered, and the locomotive pulls ahead slowly. When the buckets are loaded they are swung up, and the rear buckets are dropped and filled. The machine is then hauled rapidly to the dumping point, where the buckets are dumped, and returned for another load.

FIG. 2. PLOWING ROADBED WITH DITCHING MACHINE

For spreading material dumped along the track on fills or in yards there is a scraper blade hinged against the side of the car, as shown beneath the rear bucket in Fig. 1. Where the material is too hard for excavating by the buckets or where hard material is to be loosened for widening the roadbed beyond the reach of the bucket, the

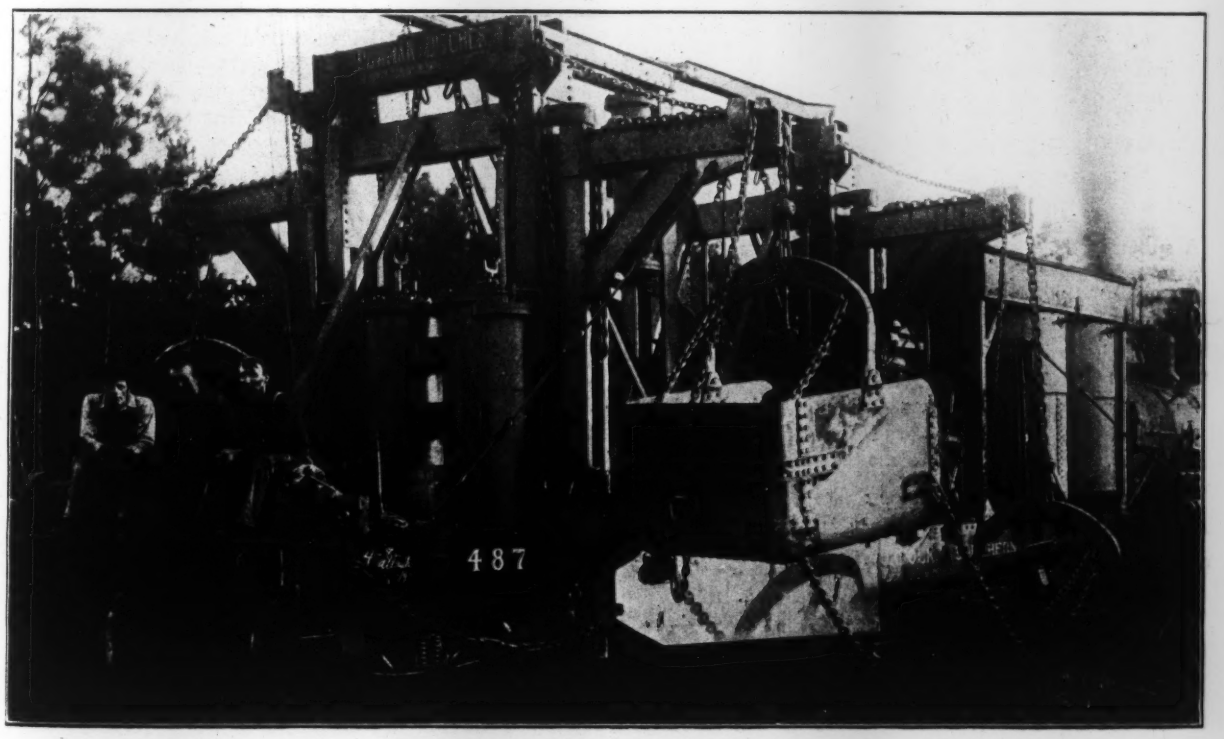


FIG. 1. RAILWAY DITCHING AND GRADING MACHINE; NORFOLK SOUTHERN R.R.

The forward bucket is shown lowered and the rear one raised. Beneath the latter is the scraper board or leveler. The vertical cylinders operate the buckets. The horizontal cylinders at the rear are to govern the position of a plow attachment.

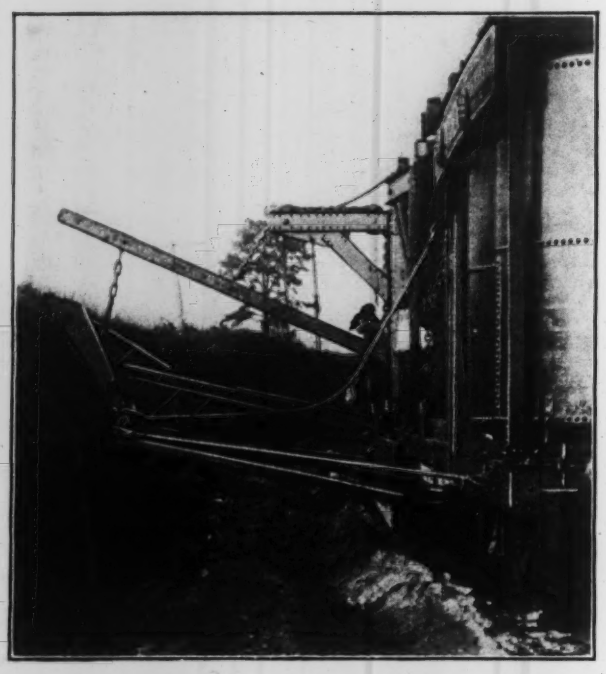


FIG. 3. TRIMMING THE SLOPES OF CUTS WITH THE DITCHING MACHINE

machine handles a heavy plow, which is illustrated in Fig. 2. For dressing slopes or widening cuts there is a scraper attached to a pair of telescopic struts, as shown in Fig. 3. The scraper is used also to form a shoulder for the ballast.

The machine requires a crew of only three men in addition to those on the locomotive. The machine was invented by Benjamin Bowman, of Springfield, Mo., and is sold by the T. W. Snow Construction Co., Ellsworth Building, Chicago.

Repairing an Open Joint in a Submerged Water Main

By Edward M. LeFluFy*

A submerged 12-in. cast-iron flexible-joint water main through False Creek, Vancouver, B. C., failed recently by a "draw-out" caused by settlement. When examined by a diver, the pipe was found to have separated completely at the point *S*, Fig. 1, leaving an opening about 1½ in. across.

A split sleeve (Fig. 2) was designed to inclose both the bell and the spigot, and in order that this sleeve should bolt together properly and that the packing glands should

FIG. 1. REPAIRING BREAK IN 12-IN. SUBMERGED WATER MAIN, VANCOUVER, B. C.

enter without binding, it was necessary to get the pipes *A* and *B* (Fig. 1) into line. This involved raising the lower end of *B*. To avoid overstraining the other flexible joints in this operation, it was found necessary to raise and support three other joints in the pipe line. The supporting material was concrete, mixed on a scow and lowered in bags to the diver, who deposited the bags as required.

There was no objection to raising the main above the bed of the creek as indicated, as False Creek is in process of being filled in for industrial purposes and a railway terminal.

The packings used in this repair sleeve consisted of two rubber gaskets at each end, placed in position so that the joint on the inner gasket is not opposite that on the outer one.

*Assistant Engineer, Water-Works Department, Vancouver, B. C.

Erecting a New Building Around an Older One

Erecting a new suburban bank building around an older and smaller one that was kept in service during the operations is an interesting piece of structural work in Detroit. The Highland Park State Bank, at 3030 Woodward Ave., having a very large business owing to its proximity to large manufacturing plants, had outgrown its quarters. It was very desirable to avoid moving to a temporary location, and it was necessary therefore to plan some way of erecting the new structure without interfering with the business of the institution.

The old building was 50x57½ ft., two stories high, the first floor being used for banking purposes and the second floor for offices. The new building is 50x150 ft. Its main portion is only one story high and has steel columns in the side walls supporting roof trusses which span the entire width. There is secondary steel framing for the mezzanine floors.

Temporary partitions were built just inside the walls of the old structure, and the roof was supported by shoring. The exterior walls were then removed so that the contractor could proceed with the erection of the new steelwork and the exterior face of the new building. The height of the new building is sufficient to allow the roof trusses to be placed above the roof of the old building.

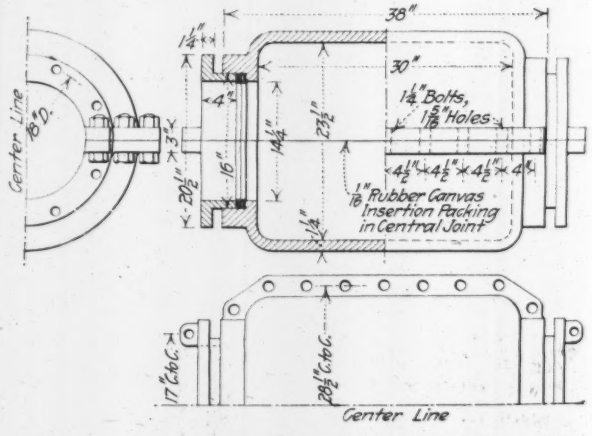
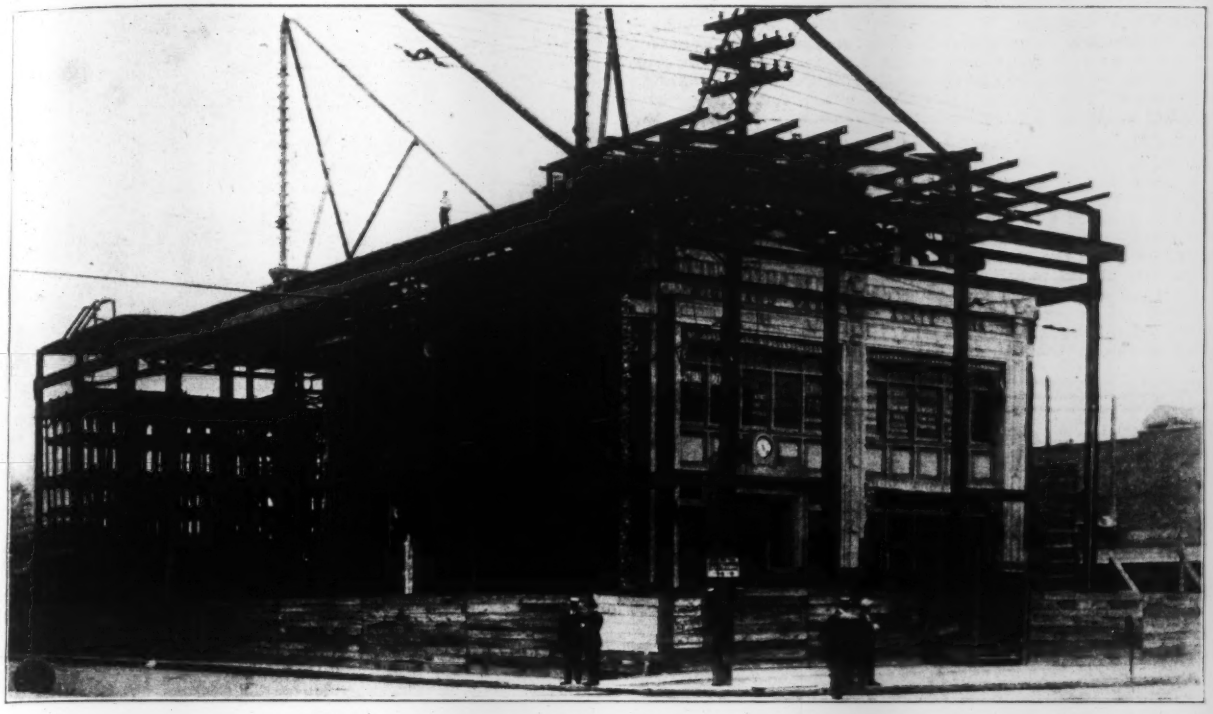


FIG. 2. SPLIT SLEEVE FOR INCLOSING BELL AND SPIGOT OF BROKEN WATER MAIN

The rear of the new building (beyond the older one) will be completed, and the bank will then move into this portion while the old structure is being removed and the new front portion completed.

The accompanying view shows the new steel framing and roof practically completed and the forms in place



ERECTING A NEW BANK BUILDING AROUND AN OLD ONE

for the concrete floors of the rear portion. The old building has its front and roof intact and a temporary partition for the side. At the right, beyond the old building, is part of the new brick exterior wall. The erection was done by means of stiff-leg derricks.

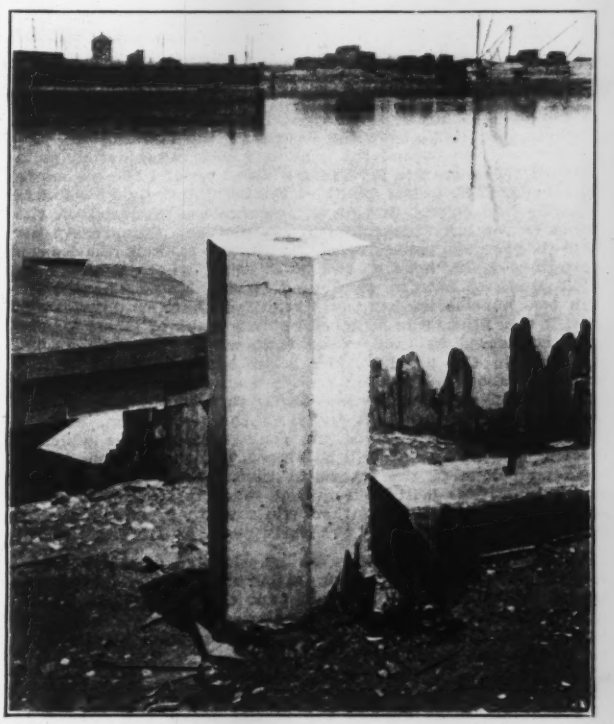
The architect for the building is Albert Kahn, and the contractor is the Albert A. Albrecht Co., both of Detroit.

NOTES

Line-Throwing Guns similar to those in use by the life-saving service for throwing lines to wrecked vessels have been installed at certain lighthouse stations on the Alaska coast to facilitate the passing of lines from the station to vessels approaching with supplies. Similar guns are to be placed on the lighthouse tenders to be used in passing lines to other vessels in heavy weather.

Tests of the Friction Coefficient of stone on stone for possible use in dam design were made by H. Shifrin and reported in a thesis for the degree of bachelor of science in civil engineering at Washington University in 1913. The article by E. L. Lasier on a similar subject in "Engineering News," July 22, 1915, p. 156, served to bring out the thesis from its place in the university archives. Mr. Shifrin's tests were made on small blocks of shale and limestone about 72 sq.in. in area, which were planed to surface and polished by rubbing one face on another. The frictional values were found by comparing the pull required to move horizontally a block piled with varying weights and resting on the other block. The pulls varied from 0 to 275 lb., and the loads from 0 to 475 lb. Average values of the coefficient of friction were as follows: Shale on shale—dry, 0.60; shale on shale—wet, 0.54; limestone on shale—dry, 0.59; limestone on shale—wet, 0.51; limestone on limestone—dry, 0.75; limestone on limestone—wet, 0.71. The first two of these figures may be compared with the corresponding values—0.61 and 0.54—found by Mr. Lasier.

Concrete-Capped Pile as Construction Benchmark—In building the Essex power station on the meadows in the southeast part of Newark, N. J., the Public Service Electric Co. engineers at the start of their operations set a permanent benchmark to be used all through the construction period. It was placed on the river bank (the whole site is in marsh), and to be immovable had to be carried down to solid ground. A pile was driven and the exposed portion of the pile was surrounded and capped with concrete, as the view shows. An instrument platform was built around the benchmark, also founded on piles, in order to make observations free from disturbance by the vibration from trains on a railway



CONCRETE-CAPPED PILE-BENCHMARK FOR CONTROL OF CONSTRUCTION, ESSEX POWER STATION

track directly alongside. The work was directed by N. A. Carle, Chief Engineer, Public Service Electric Co., Newark. This benchmark has completed its service so far as concerns the plant as now built (completed late in 1915). However, the station is designed for successive extension, by building additions on boiler house and turbine house, from the present capacity of 50,000 kw. to an ultimate capacity of 200,000 kw.

Sandblasting a Monument—So completely had smoke and dirt reduced to a dull monotone the color of the Soldiers and Sailors' Monument in the Public Square of Cleveland, Ohio, that citizens generally were surprised to learn that the stone in it is of two kinds, dissimilar in texture and color—buff sandstone and bluish granite. Sandblast is being employed to clean the stonework, which will later be heated and filled with liquid paraffin to protect it against the action of the smoky atmosphere and to give a surface which can be washed. It is easy to pick out in the picture the parts which had been cleaned at the time the photograph was taken—namely, the cannon balls at the left of the base of

A $2,000 SANDBLAST RENOVATING JOB

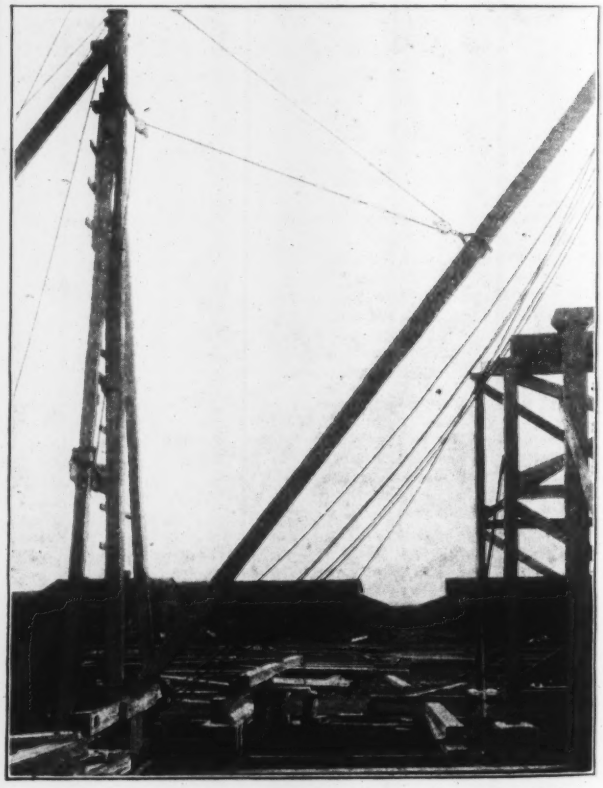
the main shaft, some of the stonework just below the cannon balls and the facade against which the ladder leans. The dust which can be seen above the figures at the right in the picture comes from behind the canvas, where sandblasting is in progress. The granite is the dark areas around the arches in the facade. The power plant of the sandblast outfit consists of a gasoline engine and an air compressor mounted on the wagon in the left foreground of the picture. Compressed air at 30-lb. pressure passes from the storage tank in the wagon through a ¾-in. hose to the sand tank, where it picks up silica sand. A 5-cu.ft. sand tank, which lasted about 1 hr. with two nozzles working and required shutting down work until it was filled, was replaced by two tanks of about 3 cu.ft. each, connected in tandem, so that when one was supplying sand to the air line, the other could be filled. Silica sand cost about $6 per ton and is used over and over. The job is taken at a lump sum—$2,000 in round numbers—and includes putting in eight gratings for ventilation, calking joints in the floor with oakum soaked in oil over which a layer of cement mortar will be placed, pointing all the stonework and cleaning the bronze statues. About three months of working time will be required to complete the job. On account of inclement weather work was suspended in November to be resumed in the spring.—C. E. Drayer.

A Small Stiff-leg Derrick on wheels was used for transporting and setting the concrete curbing of the drives and basins in front of the Kensico dam of the Catskill water-supply, New York City. It is shown by a view herewith. At the time the picture was taken the concrete blocks were being cast and stored at a point about 600 ft. to the right of the derrick. A single hauling line passing over the end of the derrick boom and attached to one of the two drums of the steam hoist snaked the blocks along the ground to a point under the boom, where they were picked up and placed by separate lifting lines. The derrick can of course

USING A SMALL DERRICK TO SET CONCRETE CURB, KENSICO DAM

move itself from place to place in a similar manner, or may be moved long distances by horses or a tractor. The contractor for this work is H. S. Kerbaugh, Inc., 6 Church St., New York City, who has the contract for all the work in connection with the dam, and who has displayed a great deal of originality in methods of construction, as described in "Engineering News" of May 21, 1915, in an article on the masonry construction work.

A Homemade Swinging-Boom Derrick was used to erect the timber framing of the bleachers at the Sheepshead Bay Motor Speedway, described in "Engineering News" of Aug. 19, 1915. The illustration shows the general construction of this derrick. An interesting detail is the joint at the base of the boom. The square timber forming the boom is rounded off with an adz or ax, and this rounded end fits in a corresponding socket carved out of two horizontal timbers fastened to the foot of the mast. The weight of the boom is all that holds it in place. The socket allows of swinging through an arc of about 45°. The motive power employed was a horse.



HOMEMADE DERRICK FOR ERECTING TIMBER BLEACHERS

Editorials

A Prosperous Society

Not many engineering societies have felt it necessary to limit their membership list from the standpoint of numbers. To annex new members, and thus increase the wealth and importance of the organization, is a general and impelling desire, especially among the local technical societies. Nor have many societies the temerity to increase their initiation fees 300% and double their annual dues, in one swoop. In view of this the following statement just issued by the American Iron and Steel Institute may occasion both surprise and envy:

> The active membership list of 1,250 is full, and the associate membership list of 250 has only 8 vacancies. The board of directors decided not to increase the number of members in either class. Temporarily some members eligible to active membership are being elected associate members. When that list shall have become filled, no more members will be electd except to fill vacancies. The board decided to increase the admission fee from $5 to $20 and the annual dues from $10 to $20, effective with the beginning of the new institute year, May 1, 1916.

How To Operate Imhoff Tanks

Highly trained engineers are freely engaged and liberally paid by many American cities to design engineering works that embody the latest theory and practice of technical science. When those very works have been completed, they are often dedicated with elaborate ceremony and a free exchange of congratulations. So far, so good. Then a change comes. The works designed and built with intelligence and skill and dedicated with high pride are delivered up for sacrifice in operation to political place hunters. The money provided for operation may be too little, too much or just about right, according to a variety of chances; but it is sure not to be spent wisely in any event. The operating results are therefore poor, the plant is not properly kept up, and everything goes from bad to worse. Then perchance the original designing engineer gets all the blame for poor results, for which he is as blameless as a new-born babe. The discredited works may then be abandoned, another engineer called in to design and build a plant of some other type and the vicious circle run once more.

In no class of municipal works has this round been run more often or more disastrously than with plants for the treatment of sewage. Taking for present purposes one element of sewage treatment—the removal and partial reduction of settleable solids—it is a notorious fact that many of the original one-story type of septic tank have fallen into disrepute because of ignorance and neglect in operation. The newer type of septic tank, known as the two-story, or Imhoff, or Emscher tank, is generally considered to be more nearly foolproof than the old type; but political vultures may be depended upon to make it other than a thing of beauty and a joy forever.

The Imhoff tank is still relatively new, but fortunately a large percentage of the many tanks of this kind now in use have been operated with a high degree of intelligence—a few even in this benighted country. A considerable body of useful experience with Imhoff tanks has been amassed. Much of this experience has been gained under the direction and still more under the eye of the man whose name the tank bears.

Conclusions based on these and other Imhoff-tank operating data are given by Dr. Imhoff elsewhere in this issue. That he lays no stress on the need of providing skilled operators is due to the fact that he lives in a part of the world where intelligent and skillful operation is so general that it is more likely to be taken for granted there than are technical training and experience in design and construction in the United States.

Routes for Freight Traffic Around Large Cities

A development of recent years in economic freight transportation is the diversion of through freight traffic around important commercial centers, relieving the railway yards at these centers from congestion and avoiding the delays which are likely to occur in the passage through a great city. The larger a city is, the more crowded will be the tracks leading into it and the greater the advantage in diverting through freight around it.

At Chicago, greatest railway focus of the country, the need for freight diversion has created several belt lines around the city; and two or three busy car-ferry lines connect railway ports in Wisconsin and Michigan across Lake Michigan, giving through traffic from the Northwest a direct route east. Experience there shows that the time saved in freight transit by such diversion routes is fully as important to the shipper as the saving in cost. At Baltimore the Pennsylvania R.R. a few years ago built a railway line around the city for the use of its through freight trains. Other belt-line transfer railways at various cities serve the same purpose of diverting through trains around the city, as well as providing for the interchange of cars between different railways.

A railway-traffic problem which has been studied for a generation is the problem of routes for the economical carriage of through freight past New York City without the delays and heavy expense which have always been necessary to send freight through it. Much space is given in this issue to a description of the New York Connecting R.R., a $30,000,000 enterprise of the Pennsylvania R.R. Co., which aims to accomplish this.

Strictly speaking, the New York Connecting R.R. will not take freight around New York City, unless one restricts the term New York City to its former limits of Manhattan Island. As at present planned, the freight cars passing over this road will still have to be transferred by a car-ferry across New York Harbor. It is probable that when the New York Connecting R.R. was first planned, it was intended to send freight trains as well as passenger trains through the tunnels under the North and East rivers. Solid trains of freight cars in a long

procession might be sent across under the rivers and Manhattan Island during those hours of the night when passenger traffic through the tunnels is very light. City authorities, however, always look with suspicion on any attempt to divert freight traffic around a city without stoppage or transfer; and in the grant of a franchise for the North River tunnels to the Pennsylvania R.R., the city authorities insisted on the insertion of a clause restricting the use of the tunnels to passenger traffic only.

The wisdom of this restriction is at least open to question. Possibly some future city administration may be wise enough to perceive that it is to the advantage of New York to have the congestion in its harbor lessened by sending through freight cars underneath the city through the tunnels instead of carrying them in car floats across the harbor already overcrowded with traffic. Even if such an enlightened administration should come into power, however, it is doubtful whether it would have the legal authority to alter the restriction in the franchise.

It may be noted further that through freight cars which pass over the New York Connecting R.R. will have to travel for a long distance over tracks crowded with suburban traffic north of the Harlem River, and on the west side of the Hudson will have to take their chances with a vast mass of other freight cars, destined for the port of New York, which enter and leave the great freight yards there. To secure greatest advantage a loop line for through freight around a city should keep clear of the city's suburbs and terminal yards. Around New York, for example, it should leave the main line in central New Jersey and not rejoin it again until well past suburban territory north of the Harlem River. The topography of the region surrounding New York, however, makes impossible the construction of any such line, chiefly by reason of the gulf, too broad and deep to be spanned by a bridge, which is formed by the Hudson River for many miles north of New York.

More than a quarter of a century ago it was attempted to divert through freight around New York by building a bridge across the Hudson River at Poughkeepsie, 75 mi. north of New York City. The amount of traffic diverted by that route, however, has been trifling compared with what the projectors of that enterprise hoped. The difficult grades and long detours necessary on the railways reaching the bridge on each side of the river were alone sufficient to explain the failure of this route.

Notwithstanding the comparative failure of the Poughkeepsie bridge route, promoters have not ceased to interest themselves in similar projects. At a point only 40 mi. north of New York in the Hudson Highlands is a site where it is possible to bridge the Hudson with a structure of moderate span. The late Gen. E. W. Serrell in the early 90's was at the head of a company which proposed to bridge the Hudson at Anthony's Nose, 5 mi. south of West Point, and spent a considerable amount on construction of the railway approaches. This project, though for many years inactive, has never been entirely abandoned. Railway lines built to reach such a bridge could have grades and distances much more favorable than those on the lines reaching the Poughkeepsie bridge. It is possible that within the next decade some of the other trunk-line railways reaching New York from the West may take up this old project and build another line for through freight traffic around New York to compete with the Pennsylvania's route over the New York Connecting R.R.

Appointing Engineers on the Public-Service Commission

Why have the engineering societies urged the appointment of engineers of ability, experience and reputation as members of state public-service commissions? They have done so first of all because they realize that commission regulation of public utilities is on trial. If regulation is to be made a success, if justice is to be done both to the public and to the public-utility corporations and those who have invested their money in them, then the public-service commissions must be made up of men who can add to the requisite character and ability, knowledge of the work they are called upon to perform.

It is important that public regulation by commission be made a success, because if it does not succeed, then public ownership is inevitable. While engineers differ more or less in their ideas as to the desirability or the reverse of public ownership and operation of public utilities, there is general agreement that we do not want to have public ownership and operation forced upon us, and that in many fields the public will be better served if private corporations perform the service under intelligent supervision by public officials.

This situation ought to be clearly understood, if not by the public at large, then at least by the leading business men and the conductors of the better part of the daily press who represent the public opinion that is of chief importance. Engineering societies have not urged the appointment of engineers on public-service commissions in order to obtain a salaried appointment for some particular engineer, but because, as citizens with the public welfare at heart, they appreciate the necessity of appointing the right class of men to administer our public-service commissions.

This is why the appointment of Henry W. Hodge as a member of the New York City Public Service Commission by Governor Whitman, commented on last week in these columns, is of such importance.

Mr. Hodge is an engineer of great ability and reputation, who accepts the appointment at a personal financial sacrifice because he recognizes the opportunity to render an important public service and recognizes also the duty a man owes to his profession and to the public.

The New York Public Service Commission is responsible for the carrying on of the largest engineering enterprise now under way in the world, as well as for the regulation of the corporations operating public utilities, in the greatest city of America. It is of great importance that the engineering profession should be represented on the administrative board which has charge of this work.

The New Orleans Screw Pumps

The great advantage of having an unusual variety of able designers inside an engineering organization built up to carry out a large and difficult piece of important work is well shown by the recent accomplishment of the New Orleans Sewage and Water Board. As noted two years ago in *Engineering News*, the Mechanical Engineer of the Board (who is a well-known pump designer) designed with the aid of his staff eleven huge pumping units which became necessary with the natural growth and extension of the city's storm-water drainage system. This "designing" was not merely the usual close determination of service conditions for the information of

competing manufacturers; but the pumps were completely designed—lock, stock and barrel—in the board's offices and from an intimate experience with the behavior of older pumps under the peculiar local conditions.

The performance of the old centrifugal units (the design and installation of which followed ordinary standard practice) was far from satisfactory, and it is debatable whether the desired improvements could have been secured at all without some development of a different type machine—and perhaps of a more neglected one like the screw pump. For instance, the suction lifts under early storm conditions generally decreased and the centrifugals automatically became overloaded, decreasing in efficiency and increasing in power draft beyond the possibilities of an economical supply. Inspection and cleaning of the pumps in their pits were possible only at intervals and under some little difficulties. The synchronous motors had to be started under load, and this necessitated the telephonic feat of slowing down distant engines and bringing generators and motors up to speed in synchronism. Expensive check gates were required for guarding against backflow. How all these adverse conditions were removed by designing the new pump propellers for use in an inverted-siphon elbow is most interestingly told by Mr. Earl elsewhere in this issue.

The new units draw maximum power only at maximum lift; and at minimum lift they pump five times the quantity of water per horsepower that the old centrifugals did. The pumps are accessible for continuous inspection; the synchronous motors can be started light and the load thrown on gradually by priming. No check gates are required. All this in itself was a noteworthy accomplishment, the rewards of which there is good reason to doubt would not have been secured in quite such measure had the board not had as its own designers the engineers on whom the old trials had borne hardest. That the designers' liberal estimate of efficiency, 70%, was exceeded by 10% and held high over a wide range is no less to the credit of the designers—though the makers share in this credit. If the New Orleans work cost a little more than it could have been farmed out for, as it probably did, the results more than justify the board's insistence on this particular procedure.

Why Not an Eight-Hour Law for Steamboat Inspectors?

A few years ago Congress passed a stringent law limiting the number of hours in a day which railway corporations may permit their trainmen to work. The Interstate Commerce Commission, which is charged with the enforcement of this law, last year prosecuted 125 cases against railway companies for infractions of the law. The reason assigned for the enactment and enforcement of the law is the securing of safety in railway service, and there is little dissent from the proposition that the requirements of the law are on the whole reasonable.

But Congress does not observe in the Government service the standards it compels railway corporations to observe in the conduct of their business. The men whom the Government employs to inspect steamboats and see that safety is observed are surely as essential to the safety of travel by water as is the work of trainmen to travel by rail. Secretary Redfield of the Department of Commerce and Labor declares that the Government employees in the Steamboat Inspection Service are seriously overworked. In his annual report to Congress a year ago he said:

> It is useless to pass more exacting laws [for the inspection of vessels] until Congress shall have given the Steamboat Inspection Service enough men to enforce the laws that already exist. In some districts men are required to work from five o'clock in the morning until ten or eleven o'clock at night. . . . It should not be necessary for a great disaster to occur before the necessary steps are taken to prevent further disaster.

In his annual report just presented, Secretary Redfield says that Congress has paid little heed to his appeal and that the overstrain went on and still continues. Besides the duties previously required of the Steamboat Inspection Service, the new seamen's law imposed fifteen or more additional duties upon it and made no provision for additions to the force. More than this, the "great disaster," of which Secretary Redfield a year ago suggested the possibility, has occurred. The "Eastland" catastrophe might have been averted had there been a competent board of naval architects in the Steamboat Inspection Service with authority to inspect the hulls of vessels, a recommendation made in previous reports by the department.

There have been many statements published reflecting on the Steamboat Inspection Service as inefficient in connection with the "Eastland" disaster and other matters. Secretary Redfield's report puts the responsibility squarely upon Congress. Secretary Redfield is not alone a Cabinet officer, whose position entitles him to speak with authority, but he is a business man of long experience accustomed to deal with labor questions, and his opinion should carry great weight. It is surely time that the Federal laws concerning the safety of travel by water were revised to suit present-day conditions, and an organization sufficient for their enforcement should be created.

Complete the Geodetic Survey of the United States

Every engineer appreciates that accurately located triangulation points and benchmarks are the first essential for accurate mapping in all classes of engineering work. As is pretty well known, the United States Coast and Geodetic Survey, besides its hydrographic surveys of the coast, has done a considerable amount of work on the extension of a network of primary triangulation over the United States. It has also done much work on a precise-level network covering the entire country.

In the annual report just issued, E. Lester Jones, superintendent of the survey, urges that this work should be carried to completion at an early date instead of being allowed to drag along for an indefinite time. When the work now planned is completed, there will be no place in the United States distant more than 100 mi. from a primary triangulation station and a precise-level benchmark. To complete the geodetic work necessary to accomplish this will cost only about $1,250,000. When this work is done and properly monumented, the results will be perpetually available.

The Federal Government alone is spending several million dollars annually for surveys and maps of various kinds. There are frequent demands upon the Coast and

Geodetic Survey already from cities which ask to have triangulation points and benchmarks established, on the basis of which city surveys can be carried on. The Survey has been unable to respond to some of these requests, on account of lack of funds.

The argument has been repeatedly brought forward in Congress that the surveys in the interior of the country should be carried on by the states themselves. There was for a long time much prejudice against the extension of the coast-survey triangulation to cover the interior of the country. Every engineer, however, can readily understand the impracticability of having each of the 48 states conduct its own system of triangulation inside its own boundaries without the aid of a primary triangulation network covering the entire continent on which to base the work.

There has been at times severe criticism of some of the surveys carried on by the Federal Government, on the ground of their inaccuracy. No such criticism has ever been made of the work done by the Coast and Geodetic Survey. Its work is fundamental to all surveying and leveling done throughout the country, since every class of civil-engineering work, and in a sense every engineer, is dependent on accurate mapping. There will be unanimous agreement among engineers that the accurate foundation work necessary for such mapping ought to be completed by the Coast and Geodetic Survey, and Congress should furnish the funds as rapidly as the work can be carried on.

Letters to the Editor

What Causes Rumbling Noise from Brick Pavements?

Sir—The writer has seen many theories as to the cause of rumbling from cement-grouted brick paving, and he has observed the phenomenon under circumstances which do not fit any of the theories. He has made some further observations that promise a theory to better fit the case.

A close examination of brick pavements laid without transverse joints reveals cracks transverse to the street and usually about 40 ft. apart. These cracks may be and usually are very fine; but they are plainly visible when the street surface is clean, as for instance after washing or after a shower.

The rumble occurs when a steel-tired wheel at speed crosses a crack. Each wheel causes a rumble, which accounts for the continuance of the noise. In all the pavements on which I have observed the phenomenon, the brick had been cement filled to form a continuous sheet from end to end of the block. Expansion joints had been laid next to the curb along both sides of the street and were in excellent order. I have not yet observed a resonant pavement in which the cracking was general, or one laid with any save cement filling.

The writer has diligently sought and has so far discovered no case of a rumble except as above stated. He would be glad to hear of either confirmation of his conclusion or definite evidence of a rumble which does not occur at a crack, as above stated. H. K. Higgins.

209 McBride St., Jackson, Mich., Dec. 20, 1915.

Illustrating the Necessity of a National Drainage Law

Sir—The present status of development of the Bristol Drainage District in Wisconsin admirably illustrates the crying need for a national law under which interstate drainage projects may be organized.

The whole situation summed up in as few words as possible is this: The land in the south central part of Kenosha County, Wisconsin, slopes wholly to the south. The available fall, for drainage, of all the land from the state line of Illinois north into this state is very slight and in fact is not great enough to construct a successful drainage ditch with a proper outlet. But by building a ditch south into Illinois a distance of about 2½ mi., all the waste marshy land of Kenosha County can be reclaimed.

I recommended this plan and designed a drainage system accordingly. On Oct. 27 bids were taken. The following day the commissioners of the drainage district consulted attorneys other than the attorney who had guided and in fact fostered the whole undertaking.

The result was a wide difference of legal opinion as to whether the drainage commission appointed under the laws of the State of Wisconsin had authority to assess land in Wisconsin to pay for construction in Illinois. One lawyer held the opinion that the commissioner who let contracts for work in another state would be personally liable for the cost of construction done outside the jurisdiction of the state laws under which he was appointed. On receiving this opinion the commissioners returned all bids; but they are anxious to go ahead with the work, if assured that they are vested with the proper authority.

At present there is $115,000 worth of work held back just because this legal technicality has never been decided in the United States Supreme Court. The total cost of construction was to be paid by Wisconsin land owners. It seems to me that, bearing this in mind, if the courts held that the interstate drain could not be accomplished by following the laws of one particular state, then Congress should enact a Federal drainage law that will make interstate projects possible.

Reclaiming land by drainage accomplishes the same results as irrigation. Irrigation is a national question and has been ably handled as such. Cases of interstate drainage constantly arise throughout the Middle West. In looking up this case, five others were discovered which were identical with the situation here.

The United States Department of Agriculture advocates putting all available land under cultivation; yet in this one locality there are thousands of acres, which the Wisconsin Agricultural Department reports rich in productive soil, going to waste for the want of an adequate drainage law. William E. O'Brien,

Kenosha, Wis., Dec. 24, 1915. Civil Engineer.

Peculiar Failure of a Grouted Brick Pavement

Sir—In your issue of Nov. 18, 1915, there is a letter by Samuel Whinery relative to the merits of sand-and-cement and mortar beds for brick pavements. We have had a peculiar experience with a grouted brick pavement laid on a dry sand-and-cement cushion buckling between rails of a street-car track. The sand and cement were mixed dry, the brick laid and rolled, then the whole was well wet with a hose to moisten the sand and cement mixture before the joints were grouted.

The buckling occurred several weeks after the pavement was finished, and the weather has been continuously colder since that time.

I should like to know if any of the readers of *Engineering News* can give information or experience as to the cause or causes of a condition of this kind.

The pavement outside of the rails was laid on an ordinary sand cushion and so far has shown no signs of buckling. Expansion joints were placed every 50 ft. in the paving between the rails. I might add that the pavement was laid on a 6-in. 1:3:6 concrete base with an additional 6 in. under the ties; 70-lb. rails were used in the track and a 3-in. special brick was laid between the rails.

F. T. GILLETT.
Engineer Vincennes Traction Co.

Vincennes, Ind., Dec. 20, 1915.

Calcium Chloride for Gravel Road Maintenance

Sir—It may be of interest in connection with the article in *Engineering News*, Dec. 9, 1915, on "Gravel Roads of New Hampshire," to note the two years' successful experience of the Connecticut State Highway Department in the use of calcium chloride for maintaining gravel roads.

We have a theory that this material should be used only on roads built of gravel and located near watercourses or large bodies of water, in order that the amount of water in the atmosphere may be as great as possible.

We have not had very much experience with the use of calcium chloride on waterbound macadam roads built with trap rock; and my impression is that the material in these roads is so hard and close-grained as to preclude the containing of water in the voids, either in or between the stone, so that we have not used calcium chloride for roads of this character.

There is a further benefit from the use of this material in that successive treatments do not injure the surface of the road or change its character, as is the case when oil is used more than three or four times.

The calcium chloride is applied to the surface of the road from a fertilizer spreader when the road is slightly moist. The moisture in the road and in the atmosphere causes the material to gradually change its appearance and form a moist mat over the surface of the road.

Five miles of different roads in the town of Middlebury was treated with calcium chloride in 1914-1915 at a cost of $1,844.29, which makes the actual cost (including patching) $368 per mi. The cost is divided as follows: Material, $1,301.49; labor, $381.74; labor (patching), $161.06; total, $1,844.29.

These roads are treated for about 14 ft. in width, and the treatment gradually extends of itself to the total width between shoulders, which is about 22 ft. The cost given we consider the maximum for roads of this type; that is, the cost will vary from $300 to $370 per mile for the calcium-chloride treatment alone.

C. J. BENNETT.
State Highway Commissioner.

Hartford, Conn., Dec. 21, 1915.

[The experimental use of calcium chloride on some of the New Hampshire gravel roads should have been referred to in the article mentioned. However, it has not been used to any extent in New Hampshire, the editor was informed, because of the added expense and because results during the past year have been highly satisfactory without its use; but in an exceptionally dry season it is very probable that the use of calcium chloride would materially assist in keeping gravel roads in a moist and dragable condition. Adding the cost of calcium-chloride treatment based on the Connecticut experience to the cost of patrol maintenance as now practiced in New Hampshire would bring the total cost of gravel-road maintenance, under adverse conditions, to between $600 and $900 per mi. per year.—Editor.]

Youngstown's Hot Bolt

Sir—P. Justus, of Cleveland, is probably correct in his letter published Dec. 30, 1915, in regard to stray currents in the Market St. bridge in Youngstown. The writer has come to the same conclusion and may add some interesting facts. The bolt in question is cold on Sundays and holidays when the building is not in use. Stray currents *from the building* seem to be the cause. Question for an electrical engineer: Will these currents cause corrosion in some part of the structure? If an eventual failure cannot be discovered in time, who is at fault—the city authorities or the Republic Iron and Steel Co.?

I. OESTERBLOM.

Youngstown, Ohio, Dec. 31, 1915.

Not Crystallization but Bad Maintenance the Trouble

Sir—I was glad to see your editorial on the failure of the Division St. bridge, of this place. "Granulation," "fatigue," "crystallization" and the acts of the Lord in general furnish a good quantity of whitewash for city officials who fail to perform their duty.

Had the Division St. bridge been cared for in 1891, during the high water, with more brains and less dynamite, and had less politics been applied to its maintenance since, it no doubt would be standing today instead of being as it now is in the bottom of the Spokane River.

Spokane, Wash., Jan. 5, 1916. H. MILLER.

Government Manufacture of Armor Plate and of projectiles is recommended by Secretary Daniels in his annual report. In 1900 Congress passed an act authorizing the Secretary of the Navy in his discretion to build an armor-plate factory. The committee at that time reported that a Government plant could manufacture armor at a cost of $263 per ton, with an output of 10,000 tons per annum. Since that recommendation was made the Government has paid over $76,000,000 for armor to private firms. The Secretary also recommends that the Government should manufacture a large proportion of the smokeless powder that it uses and should more actively employ its navy yards in shipbuilding.

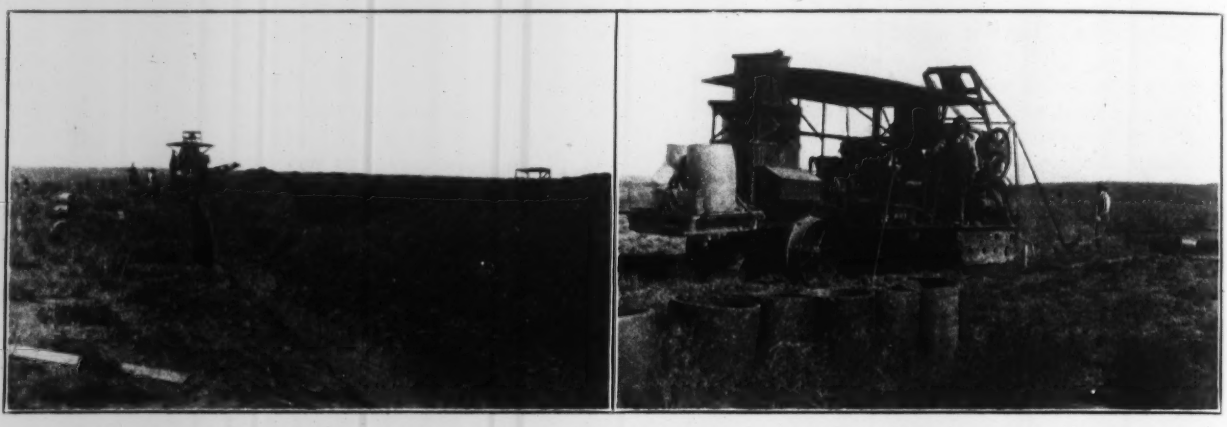
Tile-Drainage Systems for Irrigated Land

The construction of drainage systems in land which is to be irrigated is being carried out in the Pecos Valley in the neighborhood of Roswell, N. M. This work is made necessary by the presence of alkaline salts in the soil and the peculiar condition of a fluctuating level of ground-water. Under the influence of irrigation without drainage, the salts tend to work to the surface and spoil the land, while excess water may make the land too wet for agricultural use.

Drainage works for four large districts are now under construction: (1) Roswell district, east of Roswell, 12,000 acres; 100 mi. of drains; cost, $200,000. (2) Dexter-Greenfield district, 18 mi. southeast of Roswell, 19,000 acres; 145 mi. of drains; cost, $325,000. (3) Haggerman district, 7,500 acres; 65 mi. of drains; cost, $134,250. (4) East Grand Plains district, 8 mi. southeast of Roswell, 8,000 acres; 60 mi. of drains; cost, $84,000. The four districts aggregate 46,500 acres, with 370 mi. of drains and an estimated total cost of $743,250 for drainage. Work was begun in September, 1915, and will be completed in about two years. The first three are complete drainage systems. The fourth is an outlet system giving an outlet for every 40 acres.

The topography is fairly level, with a general eastward slope of 20 ft. per mi. The soil is colluvial and alluvial and very productive under a combination of irrigation and tile drainage. It is hard and dry where irrigation has not been started. In some places irrigation had been applied without provision for drainage, and here the water had converted the soil into a sticky gumbo which became almost a slushy mud where water was in excess.

The main drains are located in the draws, or natural hollows, with the lateral drains coming in at intervals of 500 to 1,500 ft. The minimum depth of the drains is about 6 ft. to the top of the tile. Owing to the high percentage of alkali in the soil, all the drains are of hard-burned vitrified salt-glazed tile. The tiles are 6 to 30 in. in diameter. They are laid with butt joints, each joint being covered with tar paper. Through the rows of cottonwood, willow and other water-seeking trees, sewer pipes with bell ends and cemented joints are used in order to prevent the roots of the trees from entering and obstructing the drains in the course of time.



FIGS. 1 AND 2. TRENCHING MACHINES WORKING IN DRY HARD SOIL IN THE PECOS VALLEY; LAND NOT YET PLACED UNDER IRRIGATION

Fig. 1—Trench made by machine. Fig. 2—Near view of machine

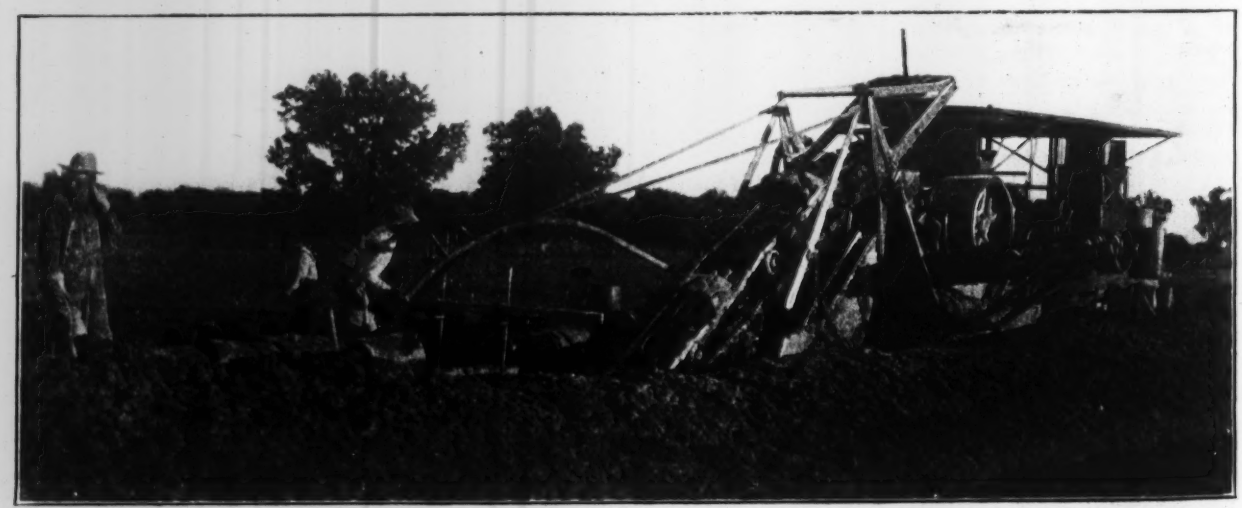


FIG. 3. TRENCHING MACHINE WORKING IN LAND MADE WET BY IRRIGATION; NO PROVISION FOR REMOVING WATER EXCEPT BY EVAPORATION

The tile is hauled and distributed along the lines of trains by wagon and teams, the average haul being 3 mi. for the Roswell and East Grand Plains districts and 1½ mi. for the others. The hauling is done by contract.

The trenching is being done by Austin gasoline trenching machines exclusively, each machine being followed by an Austin backfiller to refill the trench. The average speed of each trenching machine at depths varying from a minimum of 6 ft. to a maximum of 9 ft. is 1,000 lin.ft. per day of 9 hr. One man operates the machine, and the cost of operation is approximately $14 per day, including repairs. The backfillers are self-propelling, and each has a boom and cable attached to a scraper. One man runs the machine, and another man handles the scraper. Before these backfillers were in use, the work was done with horses and slip scrapers.

The condition of the soil varies as mentioned above. Fig. 1 shows the trenching machines at work in the dry hard soil, cutting a 10-in. trench 9 ft. deep at the rate of 2 lin.ft. per min. Fig. 2 shows the machines working in sticky gumbo and soupy clay, the effect of irrigation water that at present can escape only by evaporation. The water stands in the bottom of the trenches.

The tiles of larger sizes are lowered into the trench by means of block and tackle hitched to a tripod frame. Those of the smaller sizes are handled by a rope and a pipe-laying hook. The lines and grades are set out by the engineers. The manholes and outlets are of corrugated ingot-iron pipe. In the first three districts there will be 2,995 manholes, spaced about 500 ft. apart.

The engineer for the Roswell, Dexter-Greenfield and Hagerman districts is H. W. Vauchelet, of Roswell, N. M., to whom we are indebted for information. The contract for these three districts was let to W. S. Dickey, of the W. S. Dickey Clay Manufacturing Co., of Kansas City, Mo., which company furnishes the pipe. The construction work is being done by the Lana Construction Co., of Council Bluffs, Iowa. The engineer for the East Grand Plains district is W. A. Wilson, of Roswell, N. M.; the Bullock Co., of Kansas City, Mo., has the contract for this district.

Testing Water-Works Mains at Hartford, Conn.*

By Caleb Mills Saville†

Tests of about two miles of 8- to 20-in. cast-iron water mains recently added to the water-works of Hartford, Conn., are summarized in the accompanying table. The pipe was laid in city streets by the regular maintenance force of the department.

On the basis of nominal diameters the leakage from this line under test pressures varying from 100 to 125 lb. per sq.in. was at an average rate of 0.695 gal. per 24 hr. per lin.ft. of pipe joint, or 87.9 gal. per 24 hr. per in.-mi. of pipe.

In the tabulation, results are given in terms of linear feet of pipe joint, as the linear foot seems to be the most logical unit. Nominally, pipe joints are 12 ft. apart; practically they are seldom or never this distance. On the section of distribution pipe given in the table the laying length has varied from 10.8 to 12 ft. If there are many specials or cut pipe, the laying length may be reduced considerably below that given. As the unit—"inch diameter per mile of pipe"—must be deduced from the length of pipe joints actually exposed to leakage, the actual number of joints makes considerable difference in the result. Besides this, in almost every line there are branches and connections having various-sized joints differing from those on the main line. These must be considered in getting a unit for expressing leakage. All of these conditions readily fall in with "leakage per linear foot of joint," and for this reason that unit is considered to be well adapted for the purpose of comparing leakage for different pipe lines.

In running these tests sections between gates are ordinarily taken. The intention is to apply about 40 lb. more pressure to the section under test than will ordinarily be expected. Wherever possible the section is subjected to several different pressure heads during the test, with the intention of obtaining data as to the character of the leakage. While the information is not yet complete, the indication is that with no gates or corporation cocks open or joints blown out the loss of water varies nearly directly with the pressure. With this supposition in mind it is possible to make very reliable deductions as to the kind of leak to look for when an expressive draft is shown in the test.

DATA FROM TESTS OF NEW WATER MAINS FOR LEAKAGE, AT HARTFORD, CONN.

Diam., In.	Length, Ft.	Joints on Main Pipe No.	Joints on Main Pipe Lin. Ft.	Test Pressure, Lb. per Sq.In.	Leakage per 24-Hr. Gal. Total	Leakage per 24-Hr. Gal. Lin.Ft. of Joint
10	620	54	149a	126	140	0 947
20	2,325	194	1,017	93	130	0 128
12	1,197	102	320	106	98	0 306
12	1,327	115	399b	119	432	1 0808
12	1,070	99	341c	125	5825	1 7001
8	1,159	101	224d	109	194	0 867
12	1,054	91	309e	127	97	0 313
8	550	50	113f	120	75	0 670
8	1,076	93	206g	120	376j	1 820
8	562	49	10.6h	105	162	1 485
	10,940 = 2.07 mi.		3,077	...	2,286	0 717

a Includes four 6-in. joints. b Includes ten 8-in. joints. c Includes four 8-in. and fourteen 6-in. joints. d Includes eight 6-in. joints. e Includes fifteen 6-in. joints. f Includes four 6-in. and two 4-in. joints. g Includes six 6-in. and two 4-in. joints. h Includes four 6-in. joints. i Ordinary pressure here is 65 lb. leakage at this pressure, 27 gal. per 24 hr. j Large amount probably due to corporation cocks not entirely closed. k Includes some leakage at an 8-in. connecting gate. l Includes some leakage from an 8-in. gate.

The apparatus used in testing is the ordinary force pump for clearing obstructions from service pipes. Usually the pump has been a single hand-operated force pump, 2 in. in diameter and of 4-in. stroke, operating from a small tub. The capacity of this pump under 100 lb. pressure has been found to be about 2 gal. per min. The quantity passing the pump is measured by an ordinary meter of small size. The cost of testing, including all labor, material and supervision, has averaged about $6 per test.

*From a paper read before the New England Water-Works Association, Dec. 8, 1915.

†Chief Engineer, Board of Water Commissioners, Hartford, Conn.

The Towing Locomotives on the Panama Canal were adopted for handling ships through the locks to reduce the risk that vessels moving under their own power might collide with the lock gates. Especial care was taken in the design of the locks to guard against injury to the lock gates, heavy fender chains being hung in front of the gates to check the momentum of any vessel which might approach the gate too closely before stopping. The annual report of Capt. C. H. Rose, Superintendent of the Gatun locks, says that the ships' engines are used in starting and stopping vessels to relieve the locomotives of part of the strain and to save time. A few cases of errors or slowness by ships' engine-room forces in obeying signals have occurred, which have demonstrated the utility of having the separate towing system by towing locomotives. In all cases the locomotives have been able to stop the ship before it reached the suspended chains or the gates.

Charles Conrad Schneider

By Paul L. Wolfel*

C. C. Schneider, who died at his home in Philadelphia on Jan. 8, 1916, was born at Apolda, in the Duchy of Saxony, Germany, in the year 1843. At an early age he entered a machine shop, where he served an apprenticeship as a preliminary to his engineering education. In 1864 he graduated from the Royal School of Technology, at Chemnitz. After his graduation he spent a few years in his native land and came to this country in 1867. His first employment in his adopted land was at Paterson, N. J., where he served for about three years as designer at the Rogers Locomotive Works.

Mr. Schneider was quick to perceive the large field for development that lay in the branch of the profession that he subsequently adopted, and he chose it as the principal study of his life. His name will be prominently associated with those members of the profession who have done so much during the past forty years to study the science and perfect the art of structural engineering.

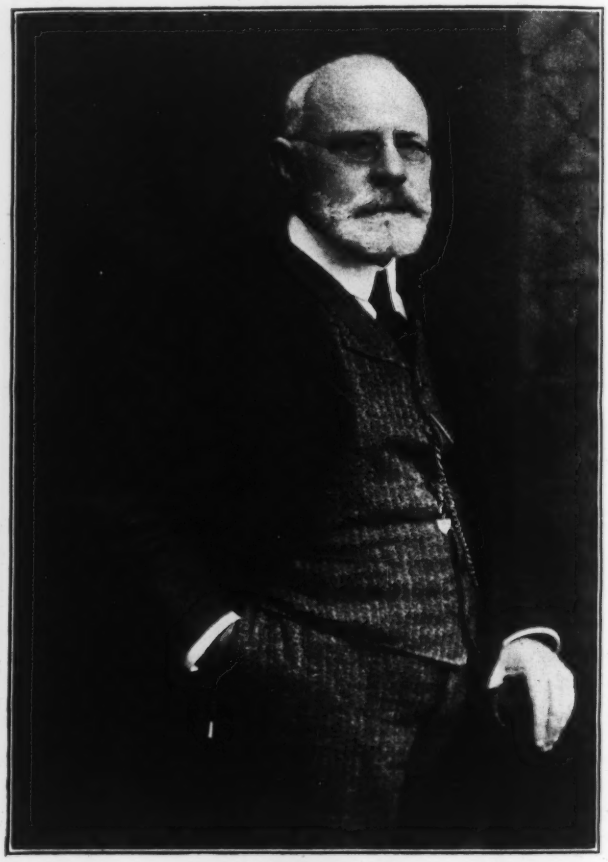
His first work in this line was with the Michigan Bridge and Construction Co., of Detroit, where he remained about three years. In 1873 he came to New York City, to take the position of Engineer-in-Charge of the engineer's office of the Erie Railroad Co., under Octave Chanute, Chief Engineer. While in the service of the Erie, one of his duties consisted in checking strain sheets and plans submitted by bridge companies. At that time this was not a general practice; railroads generally depended upon the bridge companies for the correctness of their designs. Another duty consisted in instructing inspectors. At that time experienced inspectors could not be obtained and work was generally accepted without inspection. For this reason young men employed in the office, who showed some practical ability, were selected for that purpose, and taken to some of the shops where work was in progress and given practical instruction.

The year 1873 may therefore be considered as the period at which systematic bridge inspection was commenced. The bridges which were contracted for in 1873 were let on the competitive lump-sum basis, which was then the usual practice. This, however, did not prove very satisfactory, as each bridge company at that time had its own type of truss. It was concluded that the only way to obtain a reasonable uniformity in all bridges was to have the plans prepared by the engineers of the railroad and Mr. Schneider was given that duty.

In 1874 the bridges which were needed during that year were designed by the railroad company's engineers and the work let on a pound-price basis. This was probably the first instance where bridgework was let by the pound.

In 1876 he was engaged with the Board of Engineers appointed by the Long Island Bridge Co. to pass upon competitive plans for a railroad and highway bridge across the East River, to connect Long Island with New York City. It was the intention to locate this bridge between 76th and 77th St., the location being selected as the narrowest point in the East River, requiring spans of only 734 ft. across the west channel and 618 ft. across the east channel. The project, however, was not carried out at the time on account of the financial embarrassment of the company. After this work was finished he was engaged by the Delaware Bridge Co. as a designer.

In 1877 Mr. Schneider opened an office as consulting engineer in New York City and for several years was engaged in connection with various important enterprises of that period. In 1879-1883 he was associated with the late George S. Morison on the Plattsmouth, Bismarck, Blair and Rulo bridges across the Missouri River and the Snake River bridge at Ainsworth, Wash. In the years 1882 and 1883 he designed the cantilever bridge over the Fraser River for the Canadian Pacific Ry. and the Niagara River cantilever for the Michigan Central R.R. These two bridges stand among the first of the modern type of cantilever. Mr. Schneider's name will always be associated with the development of this type of structure.



C. C Schneider

Many other important works were of his design, notably the extensive wooden viaduct at Marent Gulch on the Northern Pacific and the Stony Creek viaduct on the Canadian Pacific Ry. He also designed the anchorage for the Statue of Liberty in New York Harbor. In 1886 he was awarded the first prize for the design of a bridge over the Harlem River at New York, intended for the site of the present Washington arch bridge.

In 1886 the A. & P. Roberts Co., of the Pencoyd Iron Works, Philadelphia, added a bridge and construction department to its iron-manufacturing plant, and Mr. Schneider became associated with these works in that year

*Chief Engineer, McClintic-Marshall Co., Pittsburgh, Penn.

as Chief Engineer. The works developed very rapidly and within twelve years from their origin had a productive capacity of 8,000 tons per month, which largely exceeded the output of any bridge shops elsewhere.

In 1893 the Long Island Railroad Co. took an interest in the project of a bridge over the East River at Blackwell's Island, previously referred to, with a view of establishing a terminal in New York City. Work was actually commenced, and competitive designs for the bridge were invited in 1894. The bridge was to accommodate four railroad tracks, with approaches and a terminal station west of Second Ave., New York City. The plans adopted by the Long Island & New York Bridge Co. were the designs of Mr. Schneider, for the Pencoyd Iron Works, to which company the contract for the entire steel superstructure of the bridge and approaches was awarded in March, 1895. Considerable work had been done on this bridge on piers and foundations, complete detail drawings of the superstructure made and a portion of the material rolled, when on account of the death of Austin Corbin, President of the Long Island R.R., the company again became disorganized.

In 1900, when the American Bridge Co. was formed, Mr. Schneider was elected Vice President, in charge of engineering, which position he held until 1904, when desiring to be relieved of some of the burden, he was retained by the company as Consulting Engineer, devoting a portion of his time to private practice. He remained with the company as Consulting Engineer up to the time of his death. During this time he was also employed by the Canadian Pacific Ry. as Consulting Engineer. After the collapse of the Quebec Bridge in 1907, he was called in by the Canadian Government and made a very exhaustive report on this matter in 1908. In 1911 he was appointed by the Canadian Government a member of the Board of Engineers for the building of the new Quebec Bridge, which position he retained until his death.

Mr. Schneider has been a frequent contributor to the proceedings of the engineering societies and to the technical journals. In 1886 he received the Rowland prize from the American Society of Civil Engineers for his paper on the Niagara cantilever bridge. He also received the Norman medal in 1905 for his paper on "The Structural Design of Buildings," and again, in 1908, for a paper on "Movable Bridges." These, together with his "Standard Specifications for Railway and Highway Bridges" and volume of "Standard Details" for the American Bridge Co., form a part of his contributions to technical literature.

When Mr. Schneider wrote his first specifications for the Pencoyd Iron Works, he for the first time put his impact theory to practical use. This method of figuring has been adopted by a large number of railways and also by the American Railway Engineering Association in their specifications.

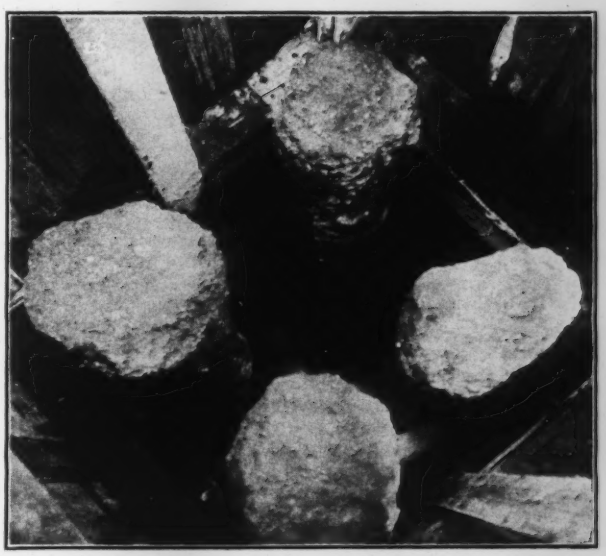
Mr. Schneider was a member of the American Society of Civil Engineers, American Railway Engineering Association, American Society for Testing Materials, the Verein Deutscher Ingenieure in Germany and the Engineers' Club in New York. He served as director in the American Society of Civil Engineers in 1887 and 1898 and was elected vice president in 1902 and president of the society in 1905.

He always stood out for good work, good designs and good details, and the present practice in bridge and structural work is greatly indebted to him for the high standard that has been obtained. He was most democratic in his ways and always ready to assist the young engineer by word and deed, and large indeed is the number of engineers today in responsible positions who owe these positions to his training and his advice. He was of a most lovable disposition and gained in the highest degree the respect of everybody who came in contact with him. His was a most useful life, well lived, an example and an inspiration to the profession that will live in the memory of all who had the privilege of knowing him.

Pedestal Pile Shafts Exposed for Test Observation

In connection with the foundation work for a new building of the American Druggists Syndicate at Long Island City, N. Y., a test of the integrity of the shafts of cast-in-place "pedestal" piles was carried out by the contractor, the MacArthur Concrete Pile and Foundation Co., at the request of John W. Moore, Superintendent of Buildings, Borough of Queens, New York City.

Four piles, spaced on the corners of a 3-ft. square, were driven with the standard pile-forming apparatus and following the standard methods of the company. Each pile was approximately 20 ft. long and was driven to a resistance of eight blows per inch, with a No. 2 Vulcan steam hammer. The piles were driven one after the other with no intervening interval, at the rate of 30 min. to the pile. The soil consists of a surface fill of the trash of an old dump, underlain by a thick marshy muck. The piles brought up on a sand stratum.



LOOKING DOWN PIT EXCAVATED AROUND FOUR "PEDESTAL" PILES

After the piles were all driven, the space was sheeted and the ground surrounding them excavated to a depth of 14 ft., or about 3 ft. above the top of the pedestal. As shown in the accompanying view, which is looking down the pit opened up around the piles, the pile shafts were all found to be of uniform section and apparently uniform density, indicating that the driving of one pile had not affected the section of the adjacent pile just driven.

News of the Engineering World

Progress of Ontario Municipal Railway Union

By-laws appropriating large sums of money for the construction of the first of the Ontario Hydro-Radial Ry. lines were passed by 16 municipalities on or about Jan. 1. Four towns rejected the ordinances and 11 have yet to vote. This interurban line runs from Toronto to London, Ont., by way of Guelph, Berlin, Stratford and St. Marys, and is intended to serve as a main line from which eventual branches will be built. The cost has been estimated by the Ontario Hydro-Electric Commission at $13,734,155. This commission will supervise the construction, equipment and operation of these lines in connection with its work of supplying power to provincial cities for their distribution.

The funds are to be raised by debentures issued by the municipalities in guarantee for their respective apportionments; these sums will be further guaranteed by the province. The principal amounts voted are: Toronto, $1,240,196; London, $1,109,303; Berlin, $774,040; Guelph, $731,862; and Stratford, $651,735.

Sir Adam Beck, chairman of the Hydro-Electric Power Commission, has stated that the first work would be on the routing of lines through the larger cities and that the first expenditures would be for rights-of-way which should be secured while the land is cheap. He intimated that construction was likely to be deferred until the close of the European War, on account of the high price of materials. The power supply needed for the railway and for increasing demands on the commission's lines would be secured by a 600,000-hp. development at Niagara Falls. The commission at present handles about 120,000 hp.

Supreme Court Settles Oregon State Highway Controversy

The Oregon State Highway Department controversy, as to whether the state engineer or the first deputy state engineer was in charge of the highway department, has been settled by the State Supreme Court after six months' litigation. The last legislature consolidated the state highway department with the office of the state engineer, with a provision that the highway work should be in charge of a first deputy engineer, appointed by the governor.

The dispute as to who should have control of the highway department began soon after the law went into effect last May. A decision as to who was legally state highway engineer was forced by the contracting firm of Peterson & Johnson, who refused to accept the first deputy's estimate of work done by them and applied for a writ of mandamus in the Supreme Court to compel the state engineer to supply the estimate.

In allowing the application for the writ the court ruled that the provision of the consolidation law which placed the highway work in charge of a chief deputy engineer was invalid. The court held that this provision conflicted with the title of the act "for consolidating the two departments." The decision does not remove the right of the governor to appoint the chief deputy engineer, but the appointment of the deputy's subordinates is declared to belong to the state engineer and not to the deputy, as has been the practice hitherto.

Collapse of Bridge at Spokane Not Yet Explained

Since the fall of the Division St. bridge, Spokane, Wash., on Dec. 18, no facts as to the cause of the failure have come to light. A board of engineers reported shortly after the accident that the lower-chord eye-bars in the end panel of one truss broke from "granulation." The finding of a coroner's jury which inquired into the

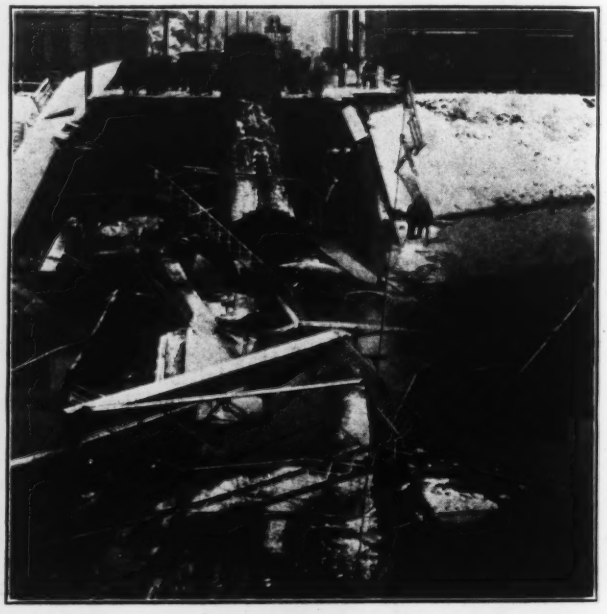


FIG. 1. THE DIVISION ST. BRIDGE AFTER COLLAPSE. LOOKING NORTH

cause of death of the five victims did not deal with the cause of the bridge failure.

The original design sheet, giving loads, stresses and make-up of members, is presented in copy herewith (Fig. 2). The illustration includes some notes as to added load, part of which was two 30-in. water mains and an 8-in. main. In the autumn of 1915 the old deck was replaced by a pavement of 4-in. creosoted wood block resting on 4-in. plank laid crosswise. The resulting total dead-load is estimated by Spokane engineers as 5,200 lb. per lin.ft. of bridge, as against 2,800 lb. provided in the design.

Vibration had proved troublesome in late years, due in part at least to automobile and motor-truck traffic and to increasing general vehicle traffic. This condition ne-

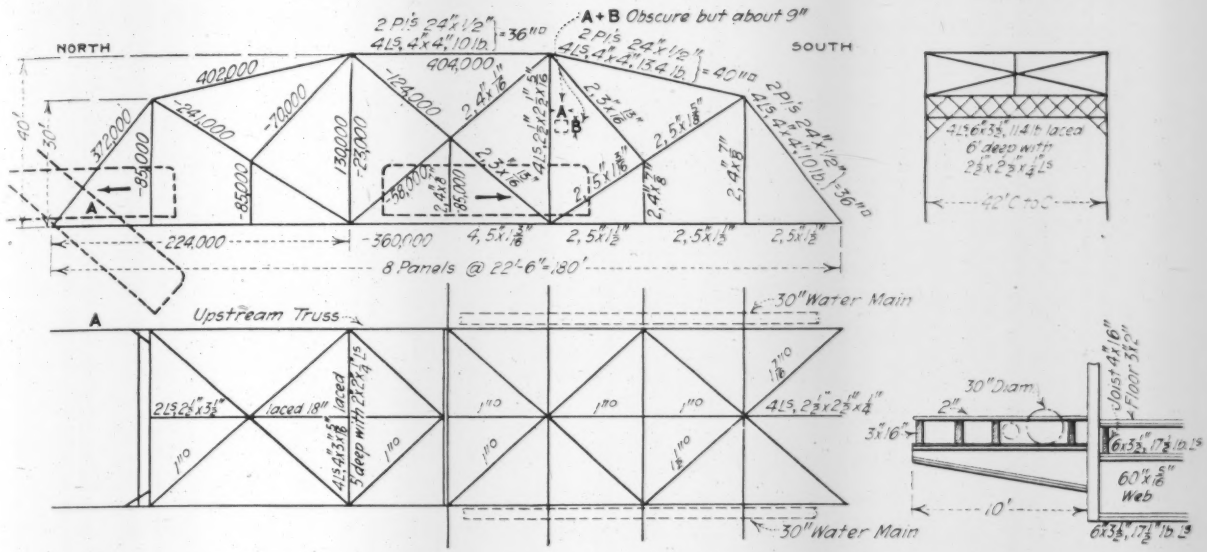


FIG. 2. COPY OF ORIGINAL "STRESS SHEET AND SECTIONS" MADE FOR DIVISION ST. BRIDGE
Some memoranda on recent changes are superimposed on the old matter. Floorbeam sketch added later

cessitated the replacement in 1914 of the old lower lateral system (adjustable rods) by a more rigid system of angles.

Damage suits for amounts totaling nearly $500,000 have been filed against the city. Pending the trial of these suits, the city authorities are not discussing the case publicly. However, City Engineer Morton Macartney is planning to have complete chemical and physical tests made of material from the bridge, as soon as all the wreckage has been recovered from the river bed. This work was delayed by cold weather but will probably be completed this week.

The city has several bridges over 20 yr. old. Though they are not overstressed, yet the city engineer has recommended that they be examined by bridge engineers and the desirability of replacing them considered, in view of the great increase in weight and amount of traffic.

FIG. 3. THE BROKEN EYEBARS AT THE NORTH END OF THE DIVISION ST. BRIDGE, SPOKANE, WASH.

Old Erie Canal Dam Fails at Tonawanda, N. Y.

A dam in the city of Tonawanda, N. Y., built in 1824 at the time of the original construction of the Erie Canal, failed on Jan. 7. The dam is a low structure built across Tonawanda Creek about half a mile above its mouth, where it empties into the Niagara River. Just above the dam the Erie Canal enters Tonawanda Creek and follows it for about 10 mi. eastward to Pendleton. The dam was built across the creek to raise the level of the water 6 to 7 ft. above that of the Niagara River. The dam itself is a wooden structure, but is flanked by masonry abutments at each bank. The level of the water above the dam is controlled by 12 flood gates at the north end of the dam and separated from it by a stone pier. While the wooden parts of the dam have of course been renewed from time to time, the masonry parts date back to the original construction of the canal. As the result of a recent thaw, the level of Tonawanda Creek was raised about 3 ft.; and although the 12 flood gates were wide open, a large volume of water was discharged over the dam. On the morning of Jan. 7 the masonry pier between the flood gates and the dam crumbled, and six of the flood gates collapsed at the same time. Shortly afterward about a third of the dam was carried out. The wreckage lodged against the piers of a bridge of the New York Central R.R., which crosses Tonawanda Creek a short distance below. A wrecking force was promptly brought to the spot, and the débris was removed before further damage was done. What will be done regarding the rebuilding of the dam is undecided, as it is not yet determined by what route the new barge canal will join the Niagara River.

A Drift-Wood Catcher has been built on the White River in Washington to prevent the log jams which sometimes cause water to back up and flood adjacent farm lands. It consists of a row of 26 concrete blocks rectangular in plan but set diagonally to the line of flow. Heavy eye-bolts project from the two upstream faces of each block, and to these are attached lengths of 1-in. steel cable. Three spacing bars divide each span into four panels, with diagonals in each to make the nine lines of cable in each length of "fence" act as a unit. The barrier, or catcher, was designed by W. J. Roberts as engineer for King and Pierce counties jointly. There is 18,000 ft. of this cable, supplied by the Broderick & Bascom Rope Co., of St. Louis, Mo.

The Railway Brotherhoods of conductors, engineers, firemen and trainmen are now taking a general ballot on the proposal that a demand shall be made upon the railway companies to establish a universal eight-hour day for all employees engaged in train service, at wages the same as those now paid, with time and a half for all overtime. The members are also voting on authorization of the heads of the brotherhoods to call a general strike of all the members in case the demand is not granted. Inasmuch as the necessities of train service compel a large proportion of train employees to work days considerably longer than eight hours, the movement is substantially a demand for a very large increase in the rate of railway wages. It is probable that few railway companies will feel financially able to grant this, and there is reason to believe that the demands of the railway employees when made will be reinforced by a general strike.

Largest Building in St. Paul Completed—The Railroad and Bank Building, St. Paul, Minn., is completed. It is now 14 stories high, but its foundations are designed for four additional stories. The ground plan is 290x232 ft., with an inner court 110x140 ft. The total floor space is 934,000 sq.ft. The building will house the general offices of the Great Northern and Northern Pacific railroads, the Northwest office of the Chicago, Burlington & Quincy and two banks. The Great Northern and the Burlington will use about half the total floor space, the Northern Pacific 400,000 sq.ft.

The building has a steel frame and concrete floor slabs, with marble, brick and terra cotta finish. The work of razing the buildings on the site began in February, 1914, and the new building was occupied on Dec. 1, 1915. The estimated cost was $4,000,000. The architect was Charles S. Frost, Chicago; the consulting engineer, the Toltz Engineering Co., St. Paul; the builder Grant Smith, St. Paul. An interesting feature is the cottage of bungalow style on the roof, 40x40 ft., with a living room, or restroom, 40x24 ft., and two bedrooms, in which directors' meetings will be held and directors from out of town may lodge.

The New Administration at Philadelphia has reappointed Carleton E. Davis Chief of the Bureau of Water. This is the more notable because the recent administration of the Department of Public Works under Morris L. Cooke was freely criticized for appointing outside experts to head the various bureaus. Mr. Davis was formerly Department Engineer of the Board of Water-Supply, City of New York.

PERSONALS

Messrs. Ezekiel C. Sargent, City Engineer, and Moses L. Brown, Commissioner of Public Works, of Quincy, Mass., have resigned.

Mr. Arthur W. Kreinheder has been selected by the new City Commission of Buffalo, of which he is a member, to head the Department of Public Works.

Mr. John J. Bracken, of Orange, N. J., has been appointed Town Engineer of Harrison, N. J., to succeed the firm of Borrie & Kreiner, which has done the town engineering work for many years.

Mr. Arthur S. Blaser, formerly with the W. I. Watson Engineering Co., has been appointed Chief Engineer for the Street Railway Commissioner of Cleveland, Ohio, at an annual salary of $3,600.

Mr. Chester E. Albright has been appointed Chief of the Bureau of Surveys, City of Philadelphia, to succeed Mr. George S. Webster, M. Am. Soc. C. E., recently appointed Director of the Department of Wharves, Docks and Ferries.

Mr. Sidney B. Williamson, M. Am. Soc. C. E., Chief of Construction in the United States Reclamation Service, with headquarters at Denver, Colo., has resigned to take charge of construction work in Chile. His resignation has been accepted and will take effect Mar. 1.

Mr. Raymond Shelby, formerly Assistant Engineer in Charge of Construction on the Glens Falls Feeder of the New York State Barge Canal, has accepted a position with the Standard Oil Co. of New York. He will be located at Batavia, Island of Java, in the East Indies.

Mr. Robert Clark Wheeler, Assoc. M. Am. Soc. C. E., Assistant Engineer with George W. Fuller, Consulting Engineer, New York City, has been appointed City Engineer of Summit, N. J., to succeed Mr. Alexander Blair, Assoc. M. Am. Soc. C. E., who resigned, to take effect Jan. 1, 1916.

Messrs. C. M. Spofford, Guy C. Emerson and F. W. Hodgdon, M.'s Am. Soc. C. E., have been appointed consulting engineers on the construction of the great new dry dock to be constructed by the Board of Directors of the Port of Boston. Mr. Hodgdon is Chief Engineer of the board.

Mr. R. W. Kelley, President of the Virginia Portland Cement Co., Allentown, Penn., together with Michael Gavin, Vice President, and F. W. White, Treasurer, have retired from their respective offices in the company. Mr. Harry C. Trexler has been elected President, E. M. Young, Vice President, and Alonzo F. Walter, Treasurer, to succeed the previously named officers.

Dr. Elmer L. Corthell and Messrs. Henry C. Allen, Eugene E. Haskell, Ernest C. Moore and Joseph Ripley, M.'s Am. Soc. C. E., have been appointed members of the Board of Consulting Engineers of the State of New York in conformity with the provisions of the Barge Canal laws of 1903 and 1911. Mr. Ripley will devote his whole time to the work and will receive a salary of $7,000 a year. The other members will receive $60 per day while engaged on state work.

Maj. F. C. Boggs, Corps of Engineers, U. S. A., M. Am. Soc. C. E., for the past eight years General Purchasing Officer of the Isthmian Canal Commission and the Panama Canal, and Chief of the Washington office, will be assigned in the near future to duty in charge of river and harbor works in the neighborhood of Montgomery, Ala. He will be succeeded by Maj. Earl I. Brown, Corps of Engineers, U. S. A., M. Am. Soc. C. E., who has had charge of the work to be taken over by Major Boggs. Major Brown has recently made a trip to the Isthmus to familiarize himself with conditions there.

OBITUARY

William Edward McDonald, Treasurer of the Flynt Building and Construction Co., of Palmer, Mass., died Dec. 11.

Ole N. Trooien, of Brookings, S. D., died Dec. 21, 1915, at 35 years of age. His illness began with an attack of the "bends" in 1908 while employed as a civil engineer in the construction of the Pennsylvania R.R. Hudson River tunnels. Mr. Trooien's "Steam Engine Investigations" thesis, written at the University of Wisconsin in 1907, attracted considerable international attention and is now largely incorporated in prominent mechanical-engineering handbooks.

Col. Alexander W. Swanitz, Civil Engineer in charge of construction of the Alaska Central R.R., died at his home in Alameda, Calif., Dec. 21. He had returned from Alaska about a month ago and was stricken with dropsy on the day of his arrival home. He was born in 1851 near Olney, Ill., and was educated in the schools near his home and at the Karlsruhe Polytechnik in Berlin and the Ecole Polytechnique in Paris. In 1872 Colonel Swanitz was appointed to a position in the engineering corps of Egypt and constructed various forts below Assuan and the harbor works at Alexandria. Later he was City Engineer of Scheveport, La. In 1880 he was appointed Chief of Construction for the Chicago & Northwestern Ry.; he also had charge of the construction of the Charleston & Macon and the New Orleans & Western railroads. In 1902 he went to Seattle to take part in the promotion and construction of the Alaska Central R.R., now known as the Alaska Northern Ry.

Stephen Betts Whiting, one of the charter members of the American Society of Mechanical Engineers, Manager from 1880 to 1882, Vice President from 1882 to 1883, and for many years owner, with his partner Charles G. Wilcox, of the firm of Wilcox & Whiting, of Camden, N. J., died Dec. 23 at his home in Cambridge, Mass. He was born at Redding Ridge, Conn., Jan. 22, 1834, and attended the schools of his home town and New Haven, finishing his education at the New Haven Collegiate and Commercial Institute. At 15 years of age Mr. Whiting was apprenticed to the machinist trade and designed and constructed a miniature steam engine, and at the age of 17 designed and built an air pump. In 1855, at 21 years of age, he went to Urbana, Ohio, to take charge of the shops of the Urbana Machine Co., and two years later became Superintendent of the Illinois Iron Works, of Alton, Ill. After several years he returned to the East to take charge of the Kaighn's Point Iron Works, which concern he and his old schoolmate, Mr. Wilcox, afterward purchased and operated under the name of Wilcox & Whiting. This firm built and erected the superstructure of the Chestnut St. bridge over the Schuylkill River in Philadelphia, and the U. S. Monitor "Koka," one of the light-draft monitors designed by John Ericsson. In 1865 the partnership was dissolved and the iron works sold, on account of Mr. Wilcox's poor health. The same year Mr. Whiting went to Pottsville, Penn., as Superintendent of the Colliery Iron Works, and while in that position he designed the Whiting system of rope drive, hauling and hoisting machinery, which was first installed at the Lehigh & Wilkes-Barre planes at Solomon's Gap, Wilkes-Barre, Penn., and which was adopted by many prominent mining companies. In 1878 he entered the employ of the Philadelphia & Reading Coal and Iron Co. as Mechanical Engineer, and was afterward made Chief Engineer and then General Manager of the company. In 1888 he became General Manager of the Calumet & Hecla Mining Co., which position he held until 1901, when he retired from active life.

ENGINEERING SOCIETIES

COMING MEETINGS

ENGINEERS' SOCIETY OF PENNSYLVANIA.
Jan. 14. Annual meeting in Harrisburg. Secy., E. R. Dasher, 30 So. Front St., Harrisburg, Penn.

CENTRAL RAILWAY CLUB.
Jan. 14. Annual meeeting in Buffalo, N. Y. Secy., H. D. Vought, 95 Liberty St., New York City.

WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION.
Jan. 14-15. Annual meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Bldg., Kansas City, Mo.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS.
Jan. 17-19. Annual meeting at Billings, Mont. Secy., C. C. Widener, Bozeman, Mont.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 18. Annual meeting in Pittsburgh. Secy., E. K. Hiles, 2511 Oliver Building, Pittsburgh, Penn.

KANSAS ENGINEERING SOCIETY.
Jan. 18-19. Annual meeting at Kansas State Agricultural College. Secy., C. A. Foster, Topeka, Kan.

AMERICAN WOOD-PRESERVERS' ASSOCIATION.
Jan. 18-20. Annual convention in Chicago. Secy., F. J. Angier, Mount Royal Station, Baltimore, Md.

THE FRANKLIN INSTITUTE.
Jan. 19. Annual meeting in Philadelphia. Secy., R. B. Owens, Philadelphia, Penn.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 19-20. Annual meeting in New York City. Secy., C. W. Hunt.

NATIONAL DRAINAGE CONGRESS.
Jan. 19-21. Annual meeting, Cairo, Ill. Vice-Pres., Edmund T. Perkins, First National Bank Building, Chicago, Ill.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Jan. 20-22. Annual convention in Minneapolis. Secy., Alvin E. Dodd, 140 West 42nd St., New York City.

ILLINOIS CHAPTER: AMERICAN WATER-WORKS ASSOCIATION.
Jan. 25-27. Annual meeting, University of Illinois, Urbana. Secy., Dr. Edward Bartow, Urbana, Ill.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 26-28. Annual meeting, University of Illinois, Urbana, Ill. Secy., E. E. R. Tratman, Wheaton, Ill.

WISCONSIN HIGHWAY COMMISSIONERS' ASSOCIATION.
Jan. 31. Annual meeting in Madison. Secy., G. H. Mainwaring, Gotham, Wis.

WISCONSIN ENGINEERING SOCIETY.
Feb. 2. Annual meeting, Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 2-5. Annual meeting in Indianapolis. Asst. Secy., W. F. King, Indianapolis, Ind.

INDIANA ENGINEERING SOCIETY.
Feb. 3-5. Annual meeting in Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Bldg., Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Feb. 4. Mid-winter meeting in Chicago. Secy., E. B. Burritt, 8 W. 40th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 8-9. Mid-winter meeting in New York City. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Feb. 9-11. Annual meeting in Columbus. Secy., John Laylin, Norwalk, Ohio.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 10-12. Annual meeting at St. Paul. Secy., Geo. H. Herrold, St. Paul, Minn.

ILLUMINATING ENGINEERING SOCIETY.
Feb. 10-11. Mid-winter convention in New York City. Secy., A. S. Miller, 29 W. 39th St., New York City.

American Water-Works Association—An organization meeting of the Four-State Section—comprising southern New Jersey, eastern Pennsylvania, Delaware and Maryland—of the American Water-Works Association will be held in Philadelphia, at the Bellevue-Stratford Hotel, on Jan. 18. Further details can be obtained from Charles R. Wood, 400 Chestnut St., Philadelphia.

The Cornell Society of Civil Engineers will hold its annual banquet at the Hotel Breslin, New York City, on Jan. 21, instead of at the Hotel McAlpin, as previously announced. The chairman of the banquet committee is Clyde Potts, 30 Church St., New York City.

The Civil Engineers' Society of St. Paul will hold its annual meeting on Jan. 15, opening with a dinner at the Commercial Club. The dinner will be followed by a program arranged by the ladies' entertainment committee, composed of the wives of outgoing officers and committee chairmen. The secretary is Carl E. Nagel.

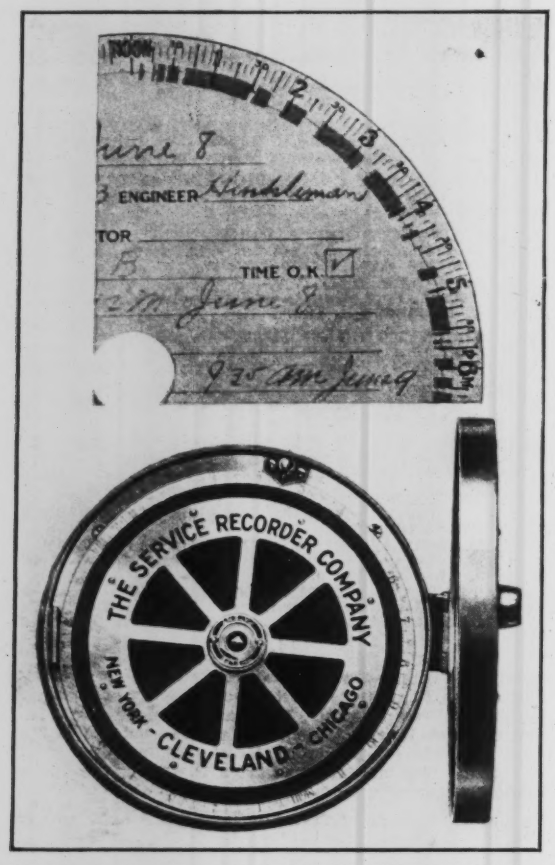
Appliances and Materials

Service Recorder for Dredges and Shovels

The "Servis Recorder" originally designed for recording the running and standing time of locomotives and motor trucks, has recently been successfully applied to steam shovels and dredges to record automatically just when and how long the equipment is working and standing. The recorder can be attached in a few minutes and is not connected to any of the running parts, being entirely self-contained.

To record operation, it uses the oscillation or sway of the equipment to which it is attached through the medium of a pendulum in it of such a period that ordinary vibration or

jars are not recorded—only that pronounced motion of the equipment which is peculiar to the actual performance of its work. The pendulum principle has been found positive and reliable in recording the movements of locomotives and vehicles and has the advantage of being simple and tamper-proof. The recorder is about 8 in. in diameter and is housed in a heavy cast-metal case. A steel protecting case is furnished in addition that can be padlocked to give extra protection against tampering and abuse. The mechanism is built to withstand severe service. The timing mechanism is a special heavy eight-day jeweled clock movement. The recording member is a sapphire-pointed stylus connected to a pendulum that is hung on a sturdy bronze bearing. The recorder is safeguarded against unauthorized opening by a plunger that cuts the chart to show at what time of day the lid is either opened or closed. The instrument needs no care or



SERVICE RECORDER FOR DREDGES; SECTION OF CHART

attention except to wind it regularly and change the charts. The accompanying view shows a "Servis Recorder" open and without its outside steel protecting case. It is manufactured by the Service Recorder Co., 2345 East 105th St., Cleveland, Ohio.

* * *

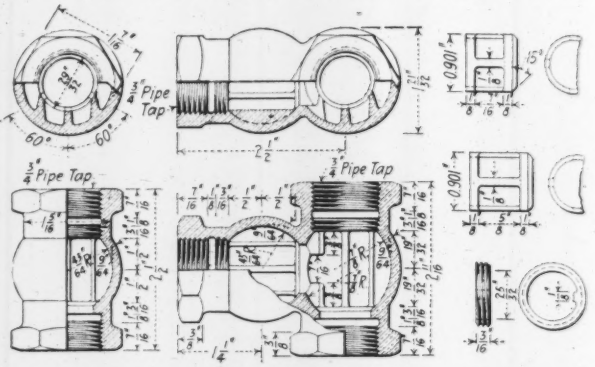
Barrel Concrete Mixer with Hoist

A small concrete mixer for farm and rural work has a barrel-shaped drum, open at one end and fitted with interior blades. For mixing, the drum is revolved on its axis by means of a chain belt passing around it. For charging and dumping, it can be swung to any angle in the supporting frame. The capacity of the drum is 2 cu.ft. wet mix, the batch being just enough for a wheelbarrow load. The frame may also be fitted with a hoisting drum for a light cable, operated through a clutch. The mixer may be driven by hand or power. It is built by the Barrel Mixer Co., of Madison, Wis.

* * *

New Design of Check Valve

A new line of water-works check and suction (double check) valves has been developed by the M. Smolensky Manufacturing Co., Cleveland, Ohio. The principal features are shown in the accompanying sketches. The basic idea was to produce a simple design and a light construction. In the smaller sizes the seat and guides are integral with the casing, which is cast of lake copper. The valve proper is a single copper casting. In the intermediate sizes an iron housing holds copper seats; the valve is of copper. In the



SMOLENSKY SUCTION AND CHECK VALVE

largest sizes the housing and valve are of iron, fitted with copper seats and rings. A half pound of metal is thus saved in the ½-in. check valve, and 50% in the larger sizes.

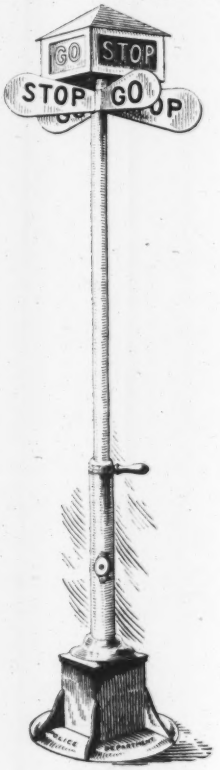
Tests are reported to show a smaller loss of pressure in the Smolensky valves than in the earlier designs. They close with smaller back pressure and may be used at any angle—even with the seat up.

The list prices run from 40c. for a ⅛-in. check to 93c. for a 1-in.; the 1¼-in. is $2.10, and the 3½-in. is $12.25. These sizes are screwed types. Flanged checks range in price from $14 for a 4-in. valve to $96 for a 9-in. and $511 for a 20-in. the suction valves range from 70c. for a 1⅛-in. size to $24.05 for a 3½-in.

* * *

Semaphore for Street-Traffic Control

It is becoming common practice to use some form of semaphore signal for regulating street traffic at busy corners rather than to depend on the whistle and hand of the traffic policeman. The most common type is a four-arm semaphore, for daylight use only, with two opposite arms painted green and lettered in white "Go," and two other opposite arms painted red and lettered "Stop." For night use, red and green bull's-eye oil lanterns are frequently attached, such as are used on railway switch signals. The semaphore design, shown in the accompanying illustration, is a litle more elaborate and exhibits the "Go" and "Stop" legends night or day. The transparent top signs are lighted by electricity either from a street connection or from a storage battery. The illustration shows the storage-battery type. The upper shaft carrying the signal is of 1¼-in. pipe, and the bottom pipe carrying the shaft is 2½ in. The shaft turns on ball bearings. This semaphore was designed and is manufactured by George L. Mesker & Co., Evansville, Ind.



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Acetylene Flare Lamps

An acetylene gas flare for general contracting, street work, fire departments, etc., has been developed by the Carbic Manufacturing Co., Duluth, Minn. This apparatus generates gas at constant pressure as required, but may be used intermittently with economy and safety. When charged for a run, no water has to be added until the entire amount of carbide is consumed. The flare complete comprises three main parts—tank, gas bell and carbide holder. The tank serves as the stand, and the bell carries the pipe column which supports the burner and reflector. The burner and reflector head is mounted on a swivel joint so that it may be swung through any angle.

The first Railroad through New York City

The New

The New York Connecting R.R

Supplement to Engineering News, Jan. 13, 1916, Vol. 75, No. 2

R.

Looking southwest across Manhattan Island